Faculty of Computer Science and Information Technology
University of Malaya
Bachelor Degree of Computer Science

The Car Parking Simulator

Prepared by
Name: Hong Lai Chin
Matric Number: WEK 020071

Supervisor:
Mrs. Norazlina Khamis

Moderater:
Assoc. Prof Dr. Lee Sai Peck

Session 2004/2005

ABSTRACT

As a fulfillment to our Computer Science Degree Program in University of Malaya, all undergraduates' students are required to accomplish a final year project (thesis) which is divided into 2 parts; there are thesis I and thesis II. In this semester, all undergraduate need to finish their thesis part I follow by thesis part II. The purpose of final year project is to let the undergraduate to put all theoretical knowledge learnt in past two years into practical before going to work. It is also as a scale to measure how much they learnt and put into practice.

I have taken project titled "The Car Parking Simulator" as my final year project. It is a web-based application which allows the respective user to simulate car parking in a realistic environment in Malaysia. The objective of this simulator is to improve the parking skills among road user and familiarize them with parking environment with minimum damage and maximum impact. This simulator will cover every type of car parking available in Malaysia which includes side parking, parallel parking and slanting parking.

Unified Process, an object-oriented methodology has been chosen as the development process. The application will develop by using Active Server Pages. (ASP) JavaScript is use as a client side scripting language and VBScript as server side scripting language. Macromedia Flash MX will also be used to for interactive and animation.

By using this application, user can simulate car parking, view information on car parking, view simulation result and generate report.

ACKNOWLEDGEMENT

First of all, I would like to express my gratitude to Mrs. Norazlina Khamis for willing to be my supervisor for final year project titled "The Car Parking Simulator". Thanks for her guidance and advices given throughout the development of the thesis project I. Constructive and useful comments given by her make the development process easier and smoother.

A special thanks to my project moderator, Assoc. Prof Dr. Lee Sai Peck for giving me the opinions and suggestions on my thesis project. Her constructive ideas and thoughts help me a lot in the project development.

Besides that, I would like to extend my thanks to my course mates and friends for their unlimited support and willingness to share their knowledge. Their willingness to share their knowledge makes my project development easier.

Last but not least, I would like to thank my family for being supported me. Their moral support help me a lots especially when I encounter problems or difficulties. The supports that given by them warming up my spirit and confidence in producing an excellent project. Without their support, the development process could be harder.

LIST OF CONTENT

LIST OF TABLE

LIST OF FIGURE

Chapter 1 Introduction

1.1 Project Overview

According to statistic shown by Jabatan Pengangkutan Jalan, Malaysia, numbers of license's drivers in Malaysia are increasing every year from 1989 until 2002. Below is the statistic on numbers of licensed driver in Malaysia provided by Jabatan Pengangkutan Jalan, Malaysia:

Table 1.1: Statistic on numbers of licensed driver in Malaysia [1]

Year	1989	1990	1991	1992	1993	1994	1995
Number of Driver	3559922	3869480	4205957	4522534	4915798	5343259	5947974
Year	1996	1997	1998	1999	2000	2001	2002
Number of Driver	6321690	6778277	7191419	7914501	8694161	9064936	9377870

Among those users who possessed license, there are still a portion of them does not master the skill of parking although some of them have drive for a quite long duration. Disability to possess a good skill in parking may cause troublesome to driver when they want to parking. The aim of this project is to improve the parking skill among licensed driver with poor parking skill and for those who are novice user, familiarize them with realistic parking environment.

This project titled "The Car Parking Simulator" will be a realistic environment which simulate the real parking environment in Malaysia in order to let user learn how

to parking through trial and error. Learning through simulation will reduce the spending of unnecessary cost due to any damage to vehicle. This system will let user practice virtually before drive in real environment.

1.2 Problems Statement

Among the problems which leads to the needs of develop a car parking simulator which allow the user to practice car parking through trial and error includes:

1) Poor parking skill among licensed drivers which can leads to the problems below:
    a) Leads to the occurrence of accidents when drivers intent to manipulate their car during parking. Driver with insufficient skills and experiences may fell very difficult to park their car properly into the boxes of parking slot especially when they come to side parking, which is the most difficult one. Drivers may crash with other car when they try to drive their car forward and backward when parking.
    b) Leads to the traffic jam when drivers on the road need to wait for a quite long queue when a poor skill's driver intends to drive his/her car from the parking slot or park into it. This type of traffic jam is unnecessary.
2) Novice users who are going to sit for their driving test normally have not enough practice to sharp their parking skill as they only allow to do practicing when guided by instructor.

1.3 Project Objectives

The objectives of the development of car parking simulator can be categories into two:

1) For licensed drivers:
    a) Improve car parking skill virtually among the drivers by providing a realistic car parking environment in order to reduce the problem caused by poor driving skill includes accidents and traffic jam.
2) For novice users:
    a) Familiarize the user with the parking environment as a preparation to undergo driving test where parking is one of the test element and for use in future.
    b) Sharpen the parking skill of novice user virtually through realistic environment.

1.4 Project Scope

1.4.1 Target User

1) Licensed drivers but still with poor parking skill because of insufficient experience and practice.
2) Novice users, who are going to sit for driving test.

1.4.2 Boundary

There will be some limitations and constraints on system will be developed. The limitations and constraints include:

1) The system will include all main realistic parking environments in Malaysia includes side parking, parallel parking and slanting parking.
2) The system will cover car parking from all direction towards the parking slot.
3) The system will be a web-based application that can be accessible by the user through internet access in any where.

1.5 Expected Outcome

The car parking simulator is expected to achieve the following outcomes:

1) A web-based application that can adapt realistic car parking environment in Malaysia in order to provide effective practices to targeted user.
2) System with user friendly graphical user interface which allow user to practice car parking in reality environment.
3) A system that enable interaction between user and system where user can control by using keyboard and mouse.
4) The system performance should meet some non-functional criteria such as reliability, consistency and stability.
5) The system developed should be able to modify for future enhancement.

1.6 Project Schedule

	Task Name	Duration	Start	Finish
1	Project Introduction	5 days	Tue 6/29/04	Mon 7/5/04
2	Literature Review	12 days	Tue 7/6/04	Wed 7/21/04
3	Methodology	8 days	Thu 7/22/04	Mon 8/2/04
4	System analysis	11 days	Tue 8/3/04	Tue 8/17/04
5	System Design	15 days	Wed 8/18/04	Tue 9/7/04
6	System Implementation	100 days	Wed 9/8/04	Tue 1/25/05
7	System Testing	81 days	Tue 10/5/04	Tue 1/25/05
8	System Evaluation	8 days	Wed 1/26/05	Fri 2/4/05

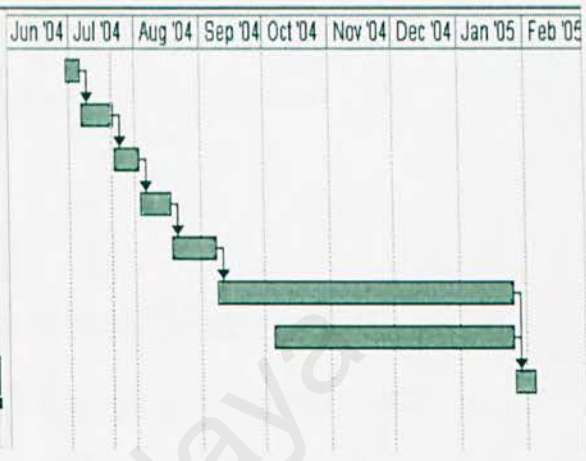


Figure 1.1: Project Gantt Chart

1.7 Report Layout

This project report consists of five chapters. The purpose of this report layout is to give an overview and summarization on every chapter in this report. Below are short descriptions of every chapter in this report:

Chapter 1: Introduction

This chapter is about introduction and overview of system going to develop, car parking simulator. This chapter includes project overview, problems statement, project objectives, project scope, expected outcome, project schedule and report layout. A reader can has a brief understanding of the project after reading chapter 1.

Chapter 2: Literature Review

This chapter is about studies and researches related to the project domain have been done in order for better understanding of the project going to work on. Literature review can be divided into two there are domain studies and technology review. The activities included in domain studies are literature search and review on existing system. Technology review is to do research on development tools, programming languages, platforms and other technologies available in helping me to develop the system.

Chapter 3: Methodology

This chapter discuss about characteristic of software development life cycle. It emphasizes on the justification of choosing the right methodology in the system development. It also discuss on the information gathering techniques used in order to elicit requirement of the system.

Chapter 4: System Analysis

This chapter will refine the system requirements gathered in previous. System requirements will analysis to determine their feasibility when puts into development. Besides from system requirement, hardware and software requirements also discuss in this chapter. After analysis on technology available and determination of requirements includes in the system development, tools and technology to be used will be finalized.

Chapter 5: System Design

This chapter discuss on the design of the system. The focus will be on architecture design, system functionality design, database design and interface design of system being develop.

Chapter 6: System Implementation

This chapter explains the implementation of the system. It discusses on the system development that convert the modules and algorithm that have been designed into programming language that can be implemented.

Chapter 7: System Testing

This chapter discusses various type of system testing that has been implemented to find out the system error, fault and failure. This is also important to make sure that the system fulfills the requirements and specifications that have been planned.

Chapter 8: System evaluation

This chapter discusses the system evaluation that reveals the problem encountered and solutions, system strength and limitation, future enhancements and others.

Chapter 2: Literature Review

Literature review is a research, evaluation and review on the information / literature related to the area of study. The purpose of the literature review is to equip the developer with the knowledge and information related to the field of study. Through literature study, developer can find out and understand what are the features and requirements should include into the system by studying the existing or similar system and the feasibility of the features by analyzing development tools or programming languages.

2.1 Domain Study

Domain study will help the developer in understanding the area of study. Well understanding in development's domain will assist developer in determines the scope and boundary of the system that is going to develop.

2.1.1 Definition & Terminologies

Simulator

Simulator is a machine, computer program or system that simulates/imitates an environment for the purpose of training or research. [2] Through simulation, real parking phenomenon will be adapted into the system and allows user to practice car parking virtually without using a car and down to the road but likely to occur in real situation.

Car parking

Car parking is a technique to bring a vehicle to stop and keep standing in a parking slot. [3] Common car parking technique in Malaysia includes side parking, parallel parking and slanting parking. These three types of parking technique consist of forward parking and reverse parking.

Table 2.1: Parking Type in Malaysia

Side Parking	Parallel Parking	Slanting parking
		

Realistic Environment

Realistic environment means circumstances or conditions created are similar to real environment. The parking environments created in the system have to be realistic in order users can adapt to real parking environment. Examples of parking environment in Malaysia includes road side parking slot, shopping complex parking slot and house garage. The objects in this environment include shops, houses, roads, cars and others.

Familiarization of users on parking environment will assists in improving car parking technique among them.

Learn through trial and error

Learn through trial and error means gain knowledge or understanding of parking skills and techniques by eliminating errors and causes of failure in order to find out a best way to park a car. [3] This simulator gives chances to users to practice the ways of parking as many times as they want until the users master in car parking.

3-Dimensional (3-D)

3-D describes an image that provides the perception of depth. [4] Fundamentally, 3-D is a dynamic illustration created by using computer. 3-D makes images more interactive and users will feel their involvement in the scene, just like situated in the real environment. By making the car parking simulator a 3-D product, users involvement will be higher and therefore more interesting in using this software.

2-Dimensional (2-D)

2-D is a description of an entity in term of two spatial dimensions. [5] Location of these two dimensions are usually identify by a pair of co-ordinates, x and y.

2.1.2 Review on the Existing System

Existing system review plays an important role in the development of a system. By analyzing existing system, the strengths and weaknesses of current system can be

identified. Developer can learn from the strengths and try to overcome the weaknesses during the development of the system. It will avoid the possibility of repeating the same error in the system that is going to develop.

After searching through the internet, only one existing system for car parking simulator found. Because of the failure to find more existing system as a reference, decision has been made to find some similar system on car parking simulator to refer. A few similar systems have been found from the internet. Below are the description of the existing system and the similar system:

2.1.2.1 Existing System

Existing System 1: Car Parking Simulator [6]

Figure 2.1: Car Parking Simulator Screen Shoot

The Car Parking Simulator is a system that found from the internet. It is developed by using Macromedia Flash MX. A plug-in Flash Player 6 is needed in order to run the simulator.

The scope of the simulator restricted to only side parking. User of the system require to park the car into the parking slot that situated in between two parking slot that are occupied. The simulation is done by using four keys available on the keyboard, there include UP (move to front). DOWN (move to back), LEFT (turn left) and RIGHT (turn right). The user is required to park the car into the parking slot by using only all four keys.

Three links are provided to the user to start a simulation (Play), hold a simulation that is on going for a while (Pause) and stop the simulation (Stop). There is a timer that uses to calculate the time that need by the user to park the car properly into the parking lots.

The system has several strength that can be adapted in to the development of car parking simulator. The graphical user interface offered by the system is simple and easy to manipulate. Besides that, a timer is allocated in the system that allows the public to calculate time needed to finish a simulation.

System has several weaknesses. The system only includes side parking instead of all the parking type that available on the road. This form the limitation of the system as the user only has chances to practice side parking.

2.1.2.2 Similar System

Similar System 1: Interactive 3D Driving Test Simulator (I3DDTS) [7]

The I3DDTS is a system developed by undergraduates from Faculty Computer Science and Information Technology (FCSIT), University of Malaya.

The I3DDTS is a window-based courseware that can be used at driving school to train users. This system is use as a replacement for the training course that conducted manually by instructors. The objective of the system is to provide an interactive 3D driving tool to familiarize the targeted users which consist of novice users and professional users with driving test environment. In this system, 3D technology is using to deliver driver education to make it more vivid and lively.

The system is totally safe and risk free for novice user. Beside that, this system also a great tool for the instructor to improve their driving skill. The tools and platform that selected in the development of the system includes Windows 2000, Maya, Open GL and C++.

I3DDTS have several strengths, one of the strengths is the interface of the system is user friendly and easy to navigate and understanding with user manual is provided. The system also easy to use as the commands and layout are simple and well organized. Therefore, it makes the learning process easier. Besides that, no plug-in or helper application is needed in order to view the graphic and animation. The system interface is in real time rendering which make the system become more realistic and movement are smooth. I3DDTS is an offline software and can be downloaded and install in stand alone computer either in Windows or Macintosh operating system.

The system has several limitations. Lack of memory usability and processor's performance of ordinary computer cause the system could not include all the detail structure. Currently, this system is only a window-based application but not web-based application due to the bandwidth of internet connection.

Future enhancements on the system are needed for system's perfect ness. Some enhancements can be done to the system in future to make it more complete. Advanced multimedia elements should add into the system to increase its attractiveness.

Similar System 2: Raydon Virtual Driver [8]

Raydon Virtual Driver (RVD) driving simulator is a fully interactive driving simulator system. The system adapted latest technology into driver education in order to offer a comprehensive approach to teach young driver how to become a competent and safe driver. RVD driving simulator is able to prepare the young drivers to the challenges they may face on the road.

The RVD simulator system also has a grading system called Raydon's Performance Assessment System (PAS) to evaluate the performance and progress of each student. The marks of each lesson will be recorded as every student will have total 10 lessons.

Through RVD driving simulator, novice user can safely experience hazardous situation occur daily on roadways. The curriculums offered by RVD driving simulator give driver chances to access risk and develop critical decision making skill that important for safety driving. Besides that, the system is complemented by interactive traffics and realistic environment condition. The simulator is not going to replace the traditional driving education or instructors but to enhance driver education classes effectively.

Both driving students and instructors are gain benefits from this simulator system as the time that student can spend on driving practice has increase. On the other hand,

instructors will have more free time as part of their jobs is taken by the introduction of Performance Assessment Scoring System.

System Features

Below are the features of the RVD driving simulator:

Table 2.2 Features of RVD Driving Simulator

Features	Description
1. Standard curriculum	The syllabus or curriculum of the simulator system was developed based on American Driver & Traffic Safety Education Association.
2. Has an evaluation system called Performance Assessment Scoring System	The evaluation system will continuously evaluate the assessment of the student when they go through the driving procedures. This enables the instructor to keep track on the progress of each student and pay more attention on weak students.
3. Challenging and realistic environments	The environments like traffics, night, rains and fog are adapted into the system to familiarize the user with driving situation before down to the road.
4. Tilt steering wheel and fully adjustable seat	This make users feel themselves seem like driving a car on the road instead of playing game. Users can adjust their seat base on their height.
5. On-site instructor training	The instructor will assist novice user in learning driving skills and strategies.

RVD Driving Simulator Training Concepts

Students undergo training by using RVD driving simulator will first go through theoretical class. After interacting with the curriculum and completed each chapter, the performance of each student will monitor by the instructor by using Performance Assessment System (PAS). After that, students will introduce to driving simulation phase. In this process, students will apply what they had learnt in the theoretical class. Besides that, students will start to apply the rules of the road, learn and practice proper driving techniques and skills and begin to apply risk assessment techniques.

This driving simulator allow novice users have more experience on 'driving' before they really put themselves on the road. This simulator provides a safe and challenging environment for user to practice their driving skill.

RVD Driving Simulator Specifications

Below are the hardware specifications of RVD Driving Simulator:

Table 2.3 RVD Driving Simulator Hardware Specification

Processor	Dual Pentium III
RAM	256 Megs of SDRAM
Hard Disk	20 Giga Bytes
CD Rom	52x 32x 52x
Monitor	19" Color VGA

Below is the software specification of RVD Driving Simulator:

Table 2.4 RVD Driving Simulator Software Specification

Operating System	Windows 2000 professional

Below are the operational specifications of RVD Driving Simulator:

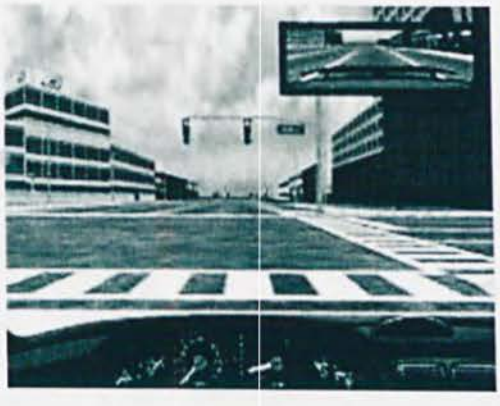
Table 2.5 RVD Driving Simulator Operational Specification

Power Requirements	120/240VAC 50/60Hz
Temperature	50° to 82°F(10°C to 28°C)
Relative Humidity	20% - 90%

RVD Driving Simulator Screen Shot

Below is the screen shot of the RVD driving simulator. The simulator consists of an adjustable seat, tilt steering, break controller and monitor.

Figure 2.2: RVD Driving Simulator



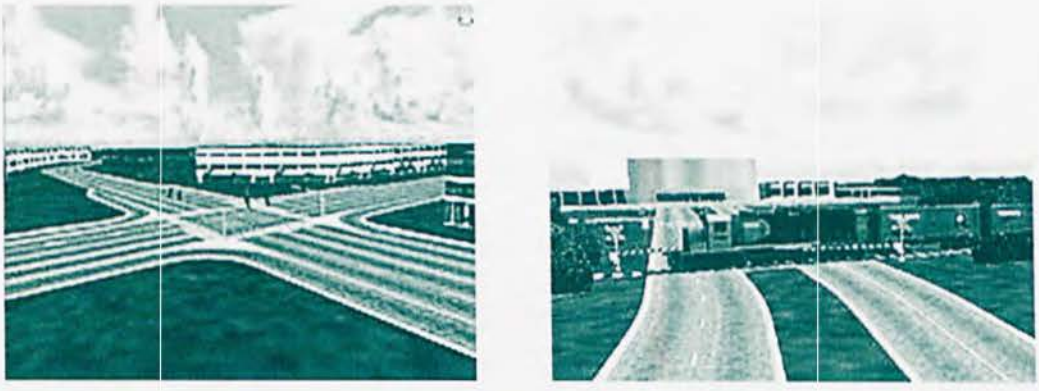


Figure 2.3: Examples of Virtual World in Simulator

Similar System 3: Myunsung Simulated Driving Trainer [9]

Myunsung Simulated Driving Trainer is a comfortable and natural driving system developed for driving training. It provides an ultimate environment by repeated virtual experience training for automobile driving skill. The simulator also supports the current driver licensing law. Practice driving by using simulator instead of really drive car on the road will eliminates the possibility of facing problems like mechanical troubles and accidents especially for novice drivers who doesn't have any experience. The concepts of this simulator are basic skills and safety. Basic skills mean by repeating the virtual driving training as many times as the users need, they will master the basic skills of driving and put into practice in future. Safety means although users make mistakes while simulation, they would not suffer from any physical damages and monetary loss.

The targeted users of the simulated driving trainer can be divided into two categories; they are the one who want to learn to drive as a beginner and the one who want to teach to drive as an instructor. The simulator in long term have reduce the cost

of training need to pay by users and also reduce the workload of the instructor as they no need to expose to bad weather.

System Configuration

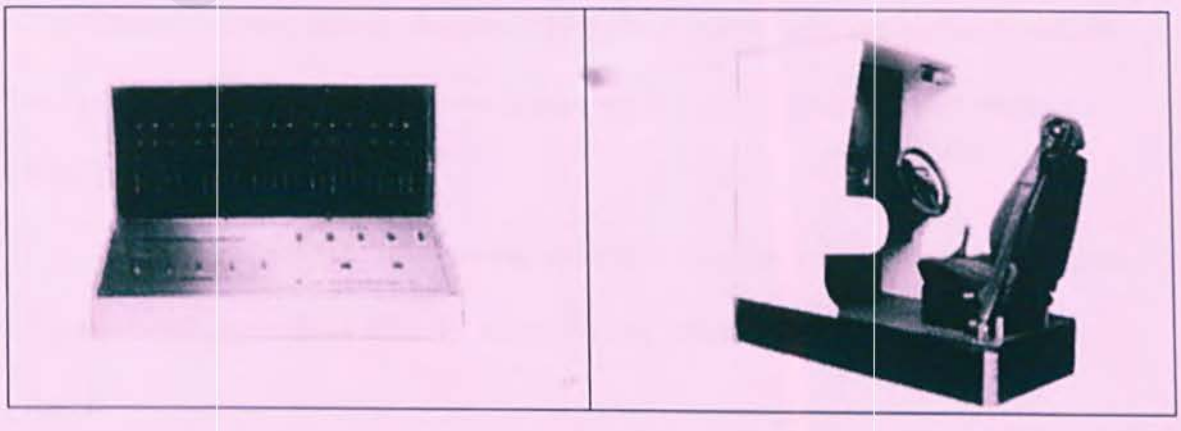
Myunsung Simulated Driving Trainer consists of a control top and 5 trainers. Below are the descriptions of each portion which form the system.

Control top:

Control top is a device use by instructor to give instructions, advices and comments to beginners. The control panel designed is compact, simple to control and easy to understand. Through the control top, instructor can recognize and identify each action by each beginner. Besides that, the instructor only needs to observe the display screen which classified functionality of the system. This can reduce the labor of the instructor.

Trainer:

Trainer is a device use by beginner to simulate virtual driving. The device consists of a monitor and multimedia driving seat. Any instruction will be given through monitor except any individual advice will give by using interphone.



Control Top	Trainer

Figure 2.4 Examples of hardware using in system

How Myunsung Simulated Driving Trainer Work?

The functionality of simulator is to provide driving training to it targeted user. The training process can be grouped into four phases, there are:

Multi Visual Training

In the early stage of the training, users will learn about the basic skills and knowledge through driving. Users learn about what is the basic position on driving, safety belt, starting engine, gear handling, departure, stop, accelerating, braking and pedaling. The basic knowledge learnt in this phase will become useful when the users come to later phases.

Virtual Driving Training

In the second phase of the training, users are given choices to select between automobile class 1 and class 2. Each selection may differ in term of the level of difficulties in skills and knowledge. Users will learn about direction control, parking skills, advance handling, pedaling and gear operation.

Travel Driving

In this phase, users are given choices between automobile class 1 and class 2. The different between second phase and third phase is that users are started to train for real examination. The scoring system is adopted to evaluate on user's performance.

Real Training Courses

In the final phase of the training, users also train for real examination situation. The users will learn about skills for safety driving which they need to implement in future.

2.1.3 Proposed System

The car parking simulator is a web-based application where the main functionality is to let the user simulate car parking. The car parking simulator will provides the targeted user with the realistic Malaysia car parking environment which enables the user learn how to park a car through trial and error.

The system will cope with 3 type of Malaysia typical car parking techniques; there are side parking, parallel parking and slanting parking. For each type of parking, the system also will cater about front and reverse parking with accumulative of 6 type of parking technique.

Car parking simulator is an interactive system which allow interaction between system and user. User can manipulate the virtual car in the system by using mouse or keyboard. The Malaysia car parking environment will adapt fully to this simulator. These is to ensure that user can adapt to real environment when really drive on the road.

2.2 Technology Review

2.2.1 Operating system/Platform

Operating system is a software program that enables the computer hardware to communicate and operate with computer software. [10] Operating system is an essential requirement in order a computer become useful and operational. The functionality of the operating system is to manage all application programs in a computer. Operating system provides a platform that enables the application programs run on it. Among the tasks that performed included identify input from input device, send output to output device, keep

track of files and directories in disk and control the peripheral device like printer and disk drive.

The operating system can be divided into different categories based on following criteria. Below are the descriptions of the different categories of operating system:

1) Graphical User Interface (GUI)
    a. Operating system in this category contains graphics and icons and normally navigation is done by using mouse. These are the type of operating system that easy to use and considered user friendly. Examples of GUI Operating Systems include System 7.x, Windows 98 and Window CE.
2) Multi-User
    a. A multi-user operating system allows the usage of same computer by multiple users at the same time/or different time. Examples of Multi-User Operating System are Linux, UNIX and Windows 2000.
3) Multiprocessing
    a. A multiprocessing operating system has the capability of supporting and utilizing more than one computer processor. Linux, UNIX and Windows 2000 are the examples of this category of operating.
4) Multitasking
    a. This type of operating system allows more than one software process run at the same time in one computer. Examples are UNIX and Windows 2000.
5) Multithreading

a. This operating system allows different parts of a software program to run concurrently. Linux, UNIX and Windows 2000 are the examples of multithreading operating system.

2.2.1.1 UNIX

UNIX was developed at Bell Laboratories by the members of Multics team in 1970's. The development of the UNIX was started as a private research project where the goals of the operating system are to design an operating system that is simple and elegant, written in high level programming language like C instead of assembly language and the code written are reusable.

UNIX is an open source operating system which allows public other than developers to do modification on the source code. Result from this, today UNIX is the enhancement version of the very first developed version because of the contribution done by organization, institutions and individuals.

Primarily, UNIX is a command line oriented operating system. [11] However, additional application such as X-Window allows UNIX's users to switch the traditional command line oriented operating system to graphic oriented operating system which is more attractive and easy to use.

The varieties of UNIX variants include AIX/AIXL, BSD, DUNIX, Sun Solaris, System V, Ultrix, Unisys, UnixWare and Xenix.

There are several features that make this operating system unanimous choice of many companies. Below are some of the features:

1) User portability - The capability of UNIX to run on a wide variety of computer systems due to the amount of code written in assembly language is

small. This 'user portability' characteristic makes many traditional companies have UNIX available on their system in addition to proprietary operating system.

2) Application portability - There are many different type of applications can be easily implemented under UNIX without writing any assembly language. In other words, these applications are portable across multiple hardware platforms.
3) Independent networking - UNIX provides independent networking this allows multiple systems located in different area to easily network.

2.2.1.2 Linux

Linux is an operating system developed by Linus Torvalds and enhanced by a number of developers and contributors. It is a freeware or open source software with the features of multitasking and multi user. Because of Linux was bound to General Public License (GPL), it can be freely distributed, redistributed, used and expended free of charge. Besides that, source code must be included in every distribution. The new function can be easily integrated and programming bugs can be fixed quickly due to the source codes accessibility. [12]

The variants of Linux are Caldera Linux, Corel Linux, Debian Linux, Kondara Linux, Red Hat Linux, Mandrake Linux, Slackware Linux, SuSE Linux, Turbolinux and Vector Linux.

Linux possess many features that make its popularity. Below are the lists of features available in Linux:

1) Multitasking, multi-user, multi platform, multiprocessing and multithreading.

2) Dynamically linked shared libraries (DLLs) and static libraries.

3) TCP/IP networking includes ftp and telnet.

4) CD-ROM File System which read all standard format of CD-ROMs.

Below is the hardware configuration of Linux:

1) Computer Processor Unit (CPU) – minimum configuration of 386s. However, all models of 386s, 486s, Pentiums, Pentium Pros, Pentium IIs and clone of these chip will work. Many DEC Alphas, SPARCs and Power machine are supported.

2) Architecture – The bus system supported by Linux include PCI, ISA, EISA and VLB busses. Compare with other operating systems like DOS and Windows, Linux demands on hardware configuration is higher.

3) Random Access Memory (RAM) – The requirement of RAM is up to 1GB on Intel and 64 bits platform. Any additional RAM needs more cache for better performance. Adding memory without adding cache will slow down machine performance. 64 MB of cache is recommended.

4) Data storage – Generic AT drives (EIDE, IDE, 16 bits HD controllers with MFM or RLL or ESDI) are supported.

2.2.1.3 Microsoft Windows

Microsoft Windows XP

Microsoft Windows XP is short form of Windows Experienced. Windows XP is a product result from the convergence of two major Microsoft operating systems. Windows XP available in two versions, there are home edition and professional edition. The targeted users of Windows XP are those who are not familiar with all the features of

Microsoft. In order to solve this problem, several new abilities have been added into this version of operating system for ease of use. Below are the additional features of Microsoft Windows XP: [13]

1) A completely new interface and users are given authority and freedom to custom own interface.
2) New features can be updated automatically as long as internet access is available.
3) A new version of Internet Explorer, Internet Explorer 6 is included in this version of operating system.
4) Windows XP support different languages.
5) Reliability of Windows XP does increased compare with the previous Microsoft Windows.

Below are the system requirements for optimum performance of Microsoft Windows XP:

Table 2.6 System Requirements of Microsoft Windows XP

Computer:	100% IBM compatible
Processor:	233 MHz or faster processor
Memory:	128 MB RAM
Drives:	1.5 GB Hard Disk space CD-ROM or DVD Drive
Sound:	Sound Card recommended
Video:	SVGA Video Card
Control:	Keyboard/Mouse
Operating System:	Upgrade Windows 98, 98SE or ME.
DirectX:	DirectX 8.1 included.
Other:	DVD requires DVD decoder with 8MB video RAM.

	Video captures feature require 400MHz or faster processor.

Microsoft Window ME

Windows ME short for Windows Millennium was introduced at September, 2000 as an upgraded version of Windows 95 and Windows 98. The design of Window ME is for end-user. This windows produced by Microsoft has a high level of similarity compare with Windows 98 but with additional fixes and features which not available in previous version of Windows.

The recommendation of Windows ME is only for those who interested with the new features introduced. Below are the short descriptions of new features added into Windows ME: [14]

1) Revert back to backup of computer - The Windows allow automatically restoration of order version of backup if any corruption or deletion of file.
2) Protect important system file - Windows ME provides the user with the ability of system file protection. Any important system file is protected by disallowing any type of modification by any software.
3) Movie Editor - Combination and editing of Microsoft movie files are allowed. Additional hardware is needed for movies importing.
4) Windows Media Player - A newest version of Windows Media Player, version 7 is included. With this player, users are offered with a more advanced way of listening and media files organization.

Below are the system requirements for optimum performance of Microsoft Windows ME:

Table 2.7 System Requirements of Microsoft Windows ME

Computer:	100% IBM Compatible
Processor:	Intel Pentium 150MHz or faster Intel Pentium 300MHz or faster for user who wish to use Windows Media Player
Memory:	32 MB RAM. 64 MB RAM for Windows Media Player
Drives:	At least 270 MB can take up to 410 MB of Hard Disk space CD-ROM or DVD drive
Sound:	Sound card with speaker recommended
Video:	Monitor with VGA or higher resolution
Control:	Keyboard/mouse
Operating system:	Requires Windows 98 for Windows ME upgrade.

Microsoft Windows 2000 [15]

Microsoft Windows 2000 Professional

Following are listed some of the important features of Windows 2000 Professional and its description:

1) Support for FAT16, FAT32 and NTFS.
2) Increase system uptime and reduce the frequency of operating system reboot scenarios.
3) Windows installer tracks applications and recognizes and replaces missing components.
4) Protects memory of individual applications and processes to avoid the system down bringing by single application.

5) File Systems encryption.

6) Secure Virtual Private Networking (VPN) supports tunneling in to private LAN over public Internet.

7) Personalized menus.

8) Multilingual version of user interface and help.

9) Support for high-speed networking devices like Native ATM and cable modems.

10) Universal Serial Bus (USB) and IEEE 1394 supported for greater bandwidth device.

Below are the system requirements for optimum performance of Microsoft Windows 2000 Professional:

Table 2.8 System requirements for Microsoft Windows 2000 Professional

Computer:	IBM or 100% Compatible
Processor:	Intel Pentium 133MHz or equivalent
Memory:	32 MB RAM.
Drives:	650 MB of Hard Disk space CD-ROM or DVD drive
Video:	VGA or higher
Control:	Microsoft keyboard/mouse or compatible
Operating system:	Requires Windows 95, 98 NT 3.5 or 4.0 for upgrade.
Direct X:	Direct X 7.0
Other:	NIC required for network installation

Microsoft Windows 2000 Server

Following are some of the significant features of Microsoft Windows 2000 Server and its short descriptions:

1) The manageability, enables security and extends interoperability with other operating system are improved by Active Directory.
2) High-level interfaces are provided for database access and Active Directory services.
3) The introduction to usage of COM+ to run component-based applications, integrated Web applications and message-queuing services.
4) An easier development and deployment of server-centric applications because of transaction services.
5) Microsoft BackOffice is fully integrated into Windows 2000 Server.

Below are system requirements for optimum performance of Microsoft Windows 2000 Server:

Table 2.9 System Requirements for Microsoft windows 2000 Server

Computer:	IBM or 100% Compatible
Processor:	Intel Pentium 133MHz or equivalent 4 CPU's supported
Memory:	256 MB RAM.
Drives:	1 GB of Disk space
Sound:	
Video:	VGA or higher monitor
Control:	Keyboard/mouse or compatible
Operating system:	Requires Windows NT Server 3.5 or 4.0

Microsoft Windows 2000 Advance Server

Below are some of the important features included in Windows 2000 Advance Server and its brief description:

1) Microsoft Windows 2000 Advanced Server is a server operating system for e-commerce and line of business applications.
2) All features in Windows 2000 Server are included with additional scalability and clustering support.
3) The reliability does increase to ensure the business critical applications are online when needed.
4) Clusters, applications and updates are easier to use and manage.
5) 8-way symmetric multiprocessing (SMP) is supported and up to 8 GB of memory (RAM)

Below are the system requirements for optimum performance of Microsoft windows 2000 Advanced Server:

Table 2.10 System Requirements for Microsoft Windows 2000 Advance Server

Computer:	IBM or 100% Compatible
Processor:	Intel Pentium 133MHz or equivalent 8 CPU's supported
Memory:	256 MB
Drives:	1 GB Disk space CD-ROM/DVD drive
Video:	VGA or higher
Control:	Microsoft Keyboard/mouse or compatible
Operating system:	Requires Windows NT Server 3.5 or 4.0

2.2.1.4 Comparison between Operating System

Table 2.11 Comparison between Linux and UNIX [12]

Features	Linux	UNIX
Availability of software or driver	Larger	Smaller
Time take to fix issues and bugs	Faster	Slower
Cost	Free/small cost	Expensive exclude UNIX versions of Sun Solaris are available for free
Scalability and maintain reliability	Lower	Higher

Table 2.12 Comparison between Linux and Windows [15]

Features	Linux	Windows
Price	Free or much lower price then Microsoft windows	Payment needed for each copy of license
Ease	Harder to user	Easy to use
Reliability	Higher	Lower
Availability of software	Not as much as Windows	Much larger
Software cost	Free/open source	Payment needed
Hardware support	Lower	Higher
Security	More	Less
Open Source	Yes	No

2.2.2 Development Environment Tools

2.2.2.1 Macromedia Flash MX

Overview

Macromedia Flash MX is a vector graphics based animation graphics program by macromedia. [16] Flash is known as authoring tool that brought the vector graphics and interactive animation to the web. Flash provides much better animation support by providing an animation framework (where timelines, frames, and graphics objects are first class citizens), mixed media (including vector graphics, bitmaps with multiple levels of transparency, anti-alias text, and sound), and a single cross-platform scripting model. Resulting files from Flash MX can be included in a website to view in web browser or play in a stand alone player. The programming language embedded in Flash is ActionScript.

Advantages

Macromedia Flash MX has several advantages that make it a popular choice of many developers:

1) Macromedia Flash MX is a vector-based program, where graphics are made up of simple lines formed by mathematic equation. The advantages of vector-based graphics includes:
    a) Clarity and quality of graphics are maintained as it resize.
    b) Fewer changes are required when the vector-based graphics changed in size or graphics, whereas bitmap increase the size.

c) Vector-based graphics is smaller than bitmaps graphics.

2) Platform independents - Macromedia Flash MX files are compatible to all platforms, such as Windows, Macintosh, Linux and Solaris.

3) Ability to run as a stand alone, offline application and web-based application.

a) For stand alone application, application can be built to nuclide both the application and its data and flash player.

b) For web-based application, application run on browser.

4) Browser independents – Macromedia Flash MX files are compatible to all browsers, such as Internet Explorer, Netscape Navigator, AOL 7 and Opera 6.

5) A multimedia platform which allow the embedded of videos, images, movies, sounds, mp3s and HTML files.

6) Flash embedded scripting language, ActionScript can be used for complex animation and interaction creation.

7) Debugger is provided for error checking.

8) The plug in, Flash Player that need to downloaded for Flash application playing includes broad support for major version of Windows, Solaris, Macintosh and Linux.

Disadvantages

Macromedia Flash MX have also have several of disadvantages, below are the list of disadvantages:

1) Flash content is not accessible to search engines.

2) Viewer plug-in don't exist for all systems, officially only for; Linux, Windows, Mac, Solaris, HP-UX, Pocket PC, OS2, and Irix platforms.

3) Flash demands significant CPU power to display, as it uses a very high degree of graphic abstraction that many video cards are not able to accelerate. Particularly, the anti-aliasing utilized by the Flash Player is heavy on the computer.
4) User need flash plug in to view the content.
5) Accessibility problems – User cannot resize the text as they can do it in HTML based web page.

File type supported by Flash

1) .fla files, a source file which contains source material for the flash application. This type of file can be edited by using Flash Authoring Software.
2) .as file or .actionscript file, contain ActionScript, the source for Flash application.
3) .swf files, a completed and published file that can not be edited.
4) .fle files, a flash video file.

System requirements

Windows:

1) Processor - Pentium 200 MHz or faster processor
2) Operating system - Microsoft Windows 98 SE, ME, NT 4.0, 2000, XP
3) Memory - 64 MB RAM(128 MB RAM are recommended)
4) Drives - 85 MB hard disk space and CD-ROM drive
5) Resolution - 1024 x 768, 16 bits color display

Macintosh:

1) Mac OS 9.1 and higher, or OS X 10.1 and higher
2) 64 MB of free available system RAM (128 MB recommended)
3) 85 MB of available disk space
4) 1024 x 768, 16-bit (thousands of colors) color display or better

5) CD-ROM drive

2.2.2.2 3D Studio Max

Features [17]

1) Powerful physically based lighting and rendering system
2) Non photorealistic rendering via a wide range of shader effects
3) Comprehensive data organization tools
4) Ability to share data with design solutions such as AutoCAD®, Autodesk®
5) Integrated workflow with Autodesk VIZ
6) Data exchange with all industry design solutions supporting DWG, DXF™, and IGES formats
7) Unique render to textual features
8) Unlimited distributed network rendering via integrated render management software
9) mental ray® rendering

System requirements

1) Processor – minimum 300 MHz processor
2) Operating system – Windows XP home, Windows XP Professional and windows 2000
3) Memory - 512 MB of RAM and 500 MB swap space minimum
4) Drives - 300 MB of free hard disk space and CD-ROM drive
5) Graphic card support 1024 x 768 16 bits color with 64MB RAM
6) Windows complaint pointing device

2.2.2.3 Adobe Photoshop 7.0

Adobe Photoshop is an image editing professional standard. It provides a comprehensive toolset, unmatched precision and powerful creative option to create professional quality image for web, print and emerging media. [18] Below are some of the features of Adobe Photoshop 7.0:

1) Allow images creation, editing and customization

2.2.2.4 Microsoft Visual Interdev 6.0

Microsoft Visual Interdev 6.0 is a web development tool that produced by Microsoft. It allowed user to create and manage dynamic web application and provide powerful tool for the creating of robust database applications. [19] Below are the features of Microsoft Visual Interdev 6.0:

1) Rapid Application Development

Rapid Application Development is the process of breaking down the development process into smaller stages. Tools available in Microsoft Visual Interdev include HTML editor, WYSIWYG editor, debugging tool and integrated development Environment.

2) Database Tools

The database tools support server databases and also can work with client IE4 data binding techniques.

3) Team-Work Based Development

Visual Interdev is compatible with FrontPage, included Personal Web Server and integrate with Visual SourceSafe.

2.2.3 Programming language

Programming language is a vocabulary and a set of grammatical rules for instructing the computer to perform specific tasks. [20]

2.2.3.1 Active Server Pages (ASP)

Active server pages (ASP) is a technology from Microsoft. The ability of ASP to extends standard HTML by adding server script language and built in object and accessing to database and other server side activeX object make the web page more dynamic and exciting instead of static. [21]

JavaScript

JavaScript is a cross platform, object-oriented client side scripting language that was developed by Netscape Communications Corporation. [22] It is originally design for the usage of Netscape Navigator. Netscape navigator has the ability to interpret the JavaScript statement that embedded in the HTML page. When there is request from browser to server, the requested HTML page that embedded with JavaScript statement will send to client by the server. The HTML pages that received from the server will then interpreted by Netscape Navigator and the result pages are displayed to clients. As it is a client side scripting language, all the processing and interpretation occur in client-side rather than server-side.

Besides that, JavaScript is also a simple to comprehend and easy to use scripting language. The success of JavaScript makes Microsoft Cooperation create Jscript, also a client side scripting language that can be considered as the clone of JavaScript with minor difference.

VBScript

VBScript or known as Microsoft Visual Basic Scripting Edition language (its full name) is a simplified version of Visual Basic or Visual basic for Applications family of programming language. It is a scripting language that created by Microsoft and is a default language for Active Server pages. [23]

VBScript is a scripting language that can enhance the HTML web pages by making it dynamic instead of static. VBScript can either serve as client-side scripting language or server-side scripting language. For VBScript that serve as client-side scripting language, with Microsoft Internet Information Server, one of it advantages is all the processing of server script occurred in server before it is transmitted to client and client only responsible for HTML pages display and do not need to concern about the ability of browser to interpret the VBScript. On the other hand, VBScript that serves as client-side scripting language, with Microsoft Internet Explorer, reduce the workload of server by transfer it to client side. But unfortunately, not all the browser can correctly interpret and display the transmitted file. Usage of VBScript as client side scripting language also exposes the source code to the browser user. But, on the bright side, a more responsive application can be produce as all the user input can be process in client side and no need to waste time to send it back to server for processing.

2.2.3.2 ActionScript

ActionScript is an object-oriented scripting language used in Macromedia Flash. It helps to manipulate flash movie. ActionScript is based on the ECMA-262 (The European Computers manufacturers Associations) specification, which is an international standard for JavaScript. The ActionScript is very similar to JavaScript in certain features and syntax. However, there are some major differences between two

scripting languages. ActionScript doesn't not support browser specific object like document, anchor or window. It also does not completely support all of the JavaScript predefined objects. Beside that, ActionScript also does not support the function constructor, or switch, continue, try, catch, throw and statement label. On the other hands, JavaScript doesn't support syntax of ActionScript like telTarget, ifFrameLoaded and others. [24]

The execution of ActionScript is sequential. The ActionScript language flows logically by executing the first statement and continuing in order until it reaches the final statement or a statement that tells ActionScript to go somewhere else.

The latest version of ActionScript is ActionScript 2.0. Compare with the previous version of ActionScript, ActionScript 1.0, strong typing and object-oriented features like explicit class definition, inheritance, encapsulation and interfaces. Both ActionScript 1.0 and 2.0 share the same compiled form within flash SWFs.

Below are the descriptions of the features available in ActionScript 2.0:

1) Everything is to be design as synchronize.
2) The XML implementation has been solid since flash 5. Flash can send and receive XML asynchronously.

2.2.4 Database

Database is a shared collection of logically related data, and a description of this data, designed to meet the information needs of an organization. Database is a very essential element in the system as it responsible for data storage, data retrieval and data editing. [25]

2.2.4.1 MySQL

MySQL database server is an open source database server that getting famous and famous among the developers because of the features that offered by MySQL. It has become the database for many core high volumes, business critical application. The advantages of MySQL include:

There is a graphical front for the MySQL database called MySQL-Front that can be used to contact directly with the database. This feature has been increase the ease of use of the database server:

1) It has high degree of compatibility as it can runs on any versions of Windows.
2) It has high reliability and performance.
3) It is easier to manage no matter it is a small scale or big scale database.
4) Structured Query Language (SQL) is using as the data manipulation language (DML) when doing the data insertion, data deletion, data modification or data request.
5) It is a cross platform database server.

2.2.4.2 Microsoft SQL Server 2000

Microsoft SQL Server 2000 is a widely use database server in many application. Here are the lists of features that offered by Ms SQL Server 2000 that makes it popular. There are many new features provided in the software which make the application perform well:

1) The ability to store a huge amount of data for the usage of web-based application.
2) The management of data is easier and well as it can perform several of queries.

3) There are many type of data format.
4) It provides a backup system that can backup data if there is any system corruption.
5) The maintenance of database is easier as it provides functions to manage it.

2.2.5 Web Browser

Web browser is a software application used to locate and display web pages. [26] Microsoft Internet Explorer and Netscape Navigator are two most popular among all existing web browser.

2.2.5.1 Internet Explorer 6.0

Internet Explorer 6.0 is a Microsoft product that is widely used all around the world. It is the most popular web browser in the world. It is embedded in all the version of Windows operating system that makes it work well with other programs and systems in Windows application. It is the browser that has been used to support the server and client's application, a widely used web-based application. Below are the advantages of Internet Explorer 6.0:

It is the most widely and commonly used web browser because it is bundled with every versions of Microsoft Windows operating system and Windows is the most widely used operating system.

1) It will automatically incorporate with plug-in that installed in the Windows.
2) It is an easy-to-use web browser because of the features provided.

2.2.5.2 Netscape Navigator

Netscape Navigator is a web browser that is compatible to Internet Explorer but it is less popular among developer if compared with Internet Explorer. It is a graphical World Wide Web (www) "browser" or "client". Www browser is software that allows user to see the content of World Wide Web. Netscape Navigator is a graphical browser that allows user to see the images and films available in World Wide Web.

2.2.6 Web Server

Web server is a computer that delivers web pages. [27] Any computer can be a web server as long as there is server software installed in the computer and connected to internet. Examples of web server software applications include Internet Information Server and Apache Server.

2.2.6.1 Internet Information Server 6.0 (IIS)

Internet Information Server is a Microsoft's web server that runs on the Windows NT platforms. It is using Hypertext Transfer Protocol (HTTP) to deliver World Wide Web documents. It incorporates with various functions for security, allows foe CGI application and also provide for Gopher and File Transfer Protocol (FTP) server. Following are some of the advantages of IIS 6.0 that make it choice of the developer.

1) It is the most widely used web server as it is available in all the version of Windows platform.
2) It is a powerful web server that provides a high reliable, manageable and scalable web application.

3) It is an easier administrate web server as it is highly integrated with the operating system, Microsoft Windows.

4) Web sites and application availability can be increased while the system administrator cost can be lowered.

2.2.6.2 Apache Server

The Apache web server that maintained by Apache Software Foundation, currently is the most popular web server due to its stability, portability and efficiency. It is an open source web server that can be run on Linux, UNIX or Windows platform. Apache exists to provide a robust and commercial-grade reference implementation of the http protocol. It remains a platform upon which individuals and institutions can build reliable systems, both for experimental purpose and for mission-critical purpose.

Chapter 3 Methodology

3.1 Software Development Life Cycle

3.1.1 Overview

Software development life cycle model is the phases that go through by the software product starting from when it is conceived until it is no longer available for use. The phases that include in the software life cycle include requirements analysis, design, construction, testing (validation), installation, operation, maintenance and retirement. The development process will go interactively through all the phases mentioned instead of linear.

Software development life cycle can be divided into two categories, there are activity-centered and entity-centered. Activity-centered life cycle means the focus of the life cycle is on the activities of software development. On the other hand, the focus of entity-centered life cycle is on the work product created by the activities in software development.

There are a lot of software development life cycle model available for developer choice but there is no ideal model that suitable for every type of software development. Every particular life cycle model has to adapt to the characteristic of each software project being developed.

3.2 Methodology consideration

The methodology can be divided into 2 categories, there are structured and object-oriented.

3.2.1 Structured methodology

3.2.1.1 Rapid prototyping Life Cycle model

A rapid prototyping life cycle model (rapid prototyping) is a life cycle that involved the construction of a rapid prototype before performs any activities or phases in the development. [28] A rapid prototype is a working model that is functionality equivalent to subset of the software product. The development of prototype should be as fast as possible to speed up the development process. The purpose of the building of rapid prototype is to identify the real needs and requirements of the software owner and future users. Experiences of interaction and usage of the working model make the stakeholder realize and clear about their requirements on the system build. This can eliminates the possibility of software products developed did not meet the product owner requirements.

According to figure 3.1, the development of software product is linear without any feedback loop, proceeding from the rapid prototyping phase until the implementation phase. This characteristic is due to the assumption of the development of requirements specification based on prototype must be correct. As a consequence, no problem should be happen in the middle of development that need the developer go back to the previous phase.

Figure 3.1 Illustration of Rapid Prototyping Life Cycle model

3.2.1.2 Spiral Life Cycle Model

Spiral life cycle model (spiral model) is a combination between waterfall model and rapid prototyping model. [28] The most important concept of spiral model is risk minimization by using of prototype preceded every phases. The spiral model focuses on addressing risks incrementally by repeating waterfall model in a series of cycles. The activities in the circles include concept of operation, software requirements, software product design, detailed design, code, unit test, integration test, acceptance test and implementation.

There are two concepts of prototype that consider important. The first concept is rapid prototyping which means prototype developed to reduce the risk of delivered product will not satisfy owner needs. The second concept is proof-of-concept

prototyping which means prototype built to test the feasibility of construction of particular part in the software product. These two type of prototyping are using for risk identification and mitigation.

Spiral model is risk driven model. Risk driven can be considered as strength if the developers are skillful enough to perform accurate risk analysis else will be a weakness.

Figure 3.2 Illustration of Spiral Life Cycle Model

3.2.1.3 V Life Cycle Model

V life cycle model (V-model) is a variant of waterfall model that associate each development activities with a test or validation at the same level of abstraction. In V-model, every development activity builds a more detail model of the system than the previous and every validation test a higher abstraction that it predecessor. V-model actually is similar with the waterfall model except it emphasize on the important of testing activities perform earlier in the life cycle. The focuses of V-model are activities and correctness.

In V-model, every test phase is considers in it matching development phase. Unit and integration testing address the correctness of program being developed. System testing performs to ensure all system design aspects are correctly implemented. Acceptance testing performs by system owner instead of developer to check whether system developed meet the agreed requirements.

According to figure 3.3, the development life cycle model is in V shape where analysis and design reside on the left hand side and testing and maintenance on the right hand side. Both are conjoint by coding phase. V-model implies that if any faults or problems found during testing and maintenance, the design and analysis phase can be re-executed to fix and improve the requirements, design and testing before validation and verification reenacted. This model enables the developer to plan for system testing when doing planning for requirements. As a result, when the system is built, test cases for system testing are done.

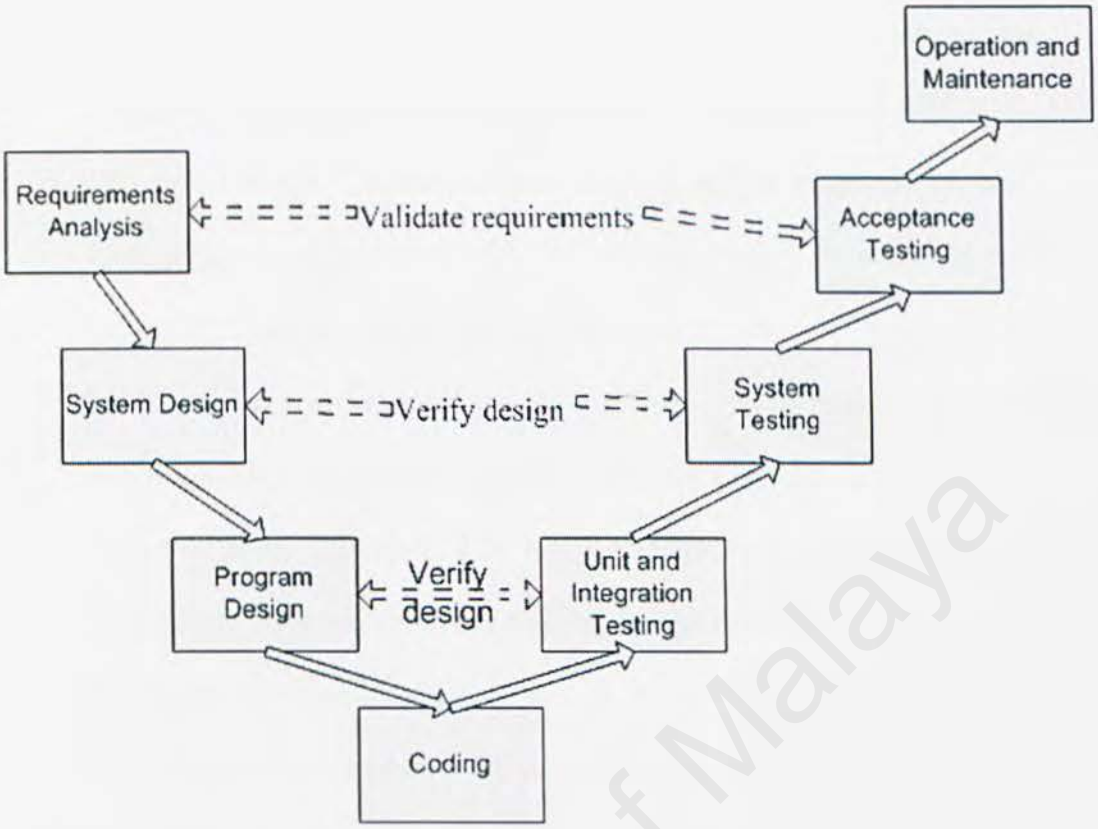


Figure 3.3 Illustration of V Life Cycle Model

3.2.2 Object-oriented methodology

3.2.2.1 Unified Process

Unified Process is the primary object-oriented methodology that widely used by developer. It is an adaptable methodology that suitable for all size of software product. The Unified Process is a use-case driven, architecture centric and iterative and incremental methodology. These characteristics make it different from other methodology and popular among the developers.

Unified process contains four phases; there are inception phase, elaboration phase, construction phase and transition phase.

1) Inception phase – The aim of the inception phase is to determine whether the targeted software product is worthwhile to develop and economically viable.
2) Elaboration phase – Elaboration phase aims to refine the initial requirement, initial architecture, monitor the risk and refine their priorities, refine the business case and produce the software project management plan.
3) Construction phase – Construction phase aims to produce the first operational-quality version of the software product. (beta release)
4) Transition phase – The aims of the transition phase is to ensure that the client's requirements have been met by collecting the feedback from the site at which the beta version has been installed.

Within the Unified Process, every phase is cut across by five workflows. The workflows are requirements, analysis, design, implementation and test.

1) Requirements workflow – The requirements and needs of the clients will determined by the development organization during this phase.
2) Analysis workflow – The requirements gathered during the requirements workflow will be analyze and refine to achieve the detailed understanding of the requirements that essential for the correct development and easier maintenance of the software product.
3) Design workflow – During this workflow, the artifacts of the analysis workflow will be refined until it is in the form that can be implemented by the programmer.
4) Implementation workflow – This workflow aims to implement the target software product in the chosen implementation languages.
5) Test workflow – Testing is carried out throughout the Unified Process and occur in parallel with other workflow. In this workflow, the artifacts from every

workflow will be tested. There are two major aspects to test; there are testing by the developer who developed it and independent testing perform by the software quality assurance (SQA) group.

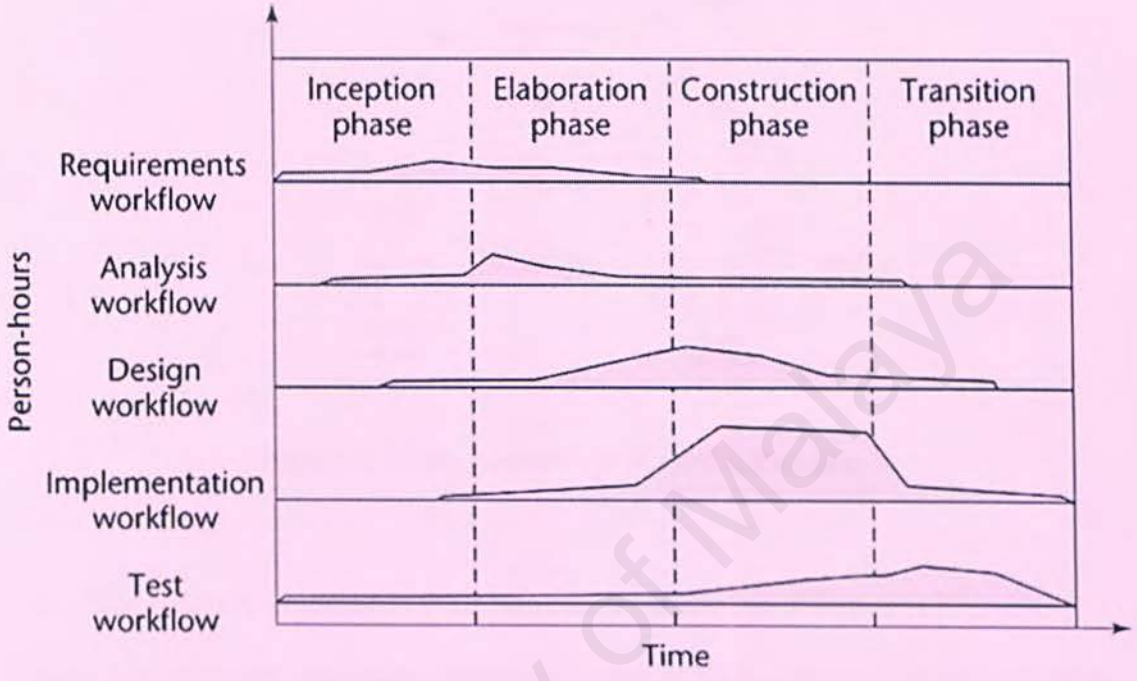


Figure 3.4 Unified process

3.2.2.2 ICONIX Process

ICONIX Process is a methodology that has some similarities with Extreme Programming. It is also a trimmed down version of Rational Unified Process (RUP). It uses minimum but sufficient subset of Unified Modeling Language (UML) to get user from use case to code quickly as shown in figure 3.4.

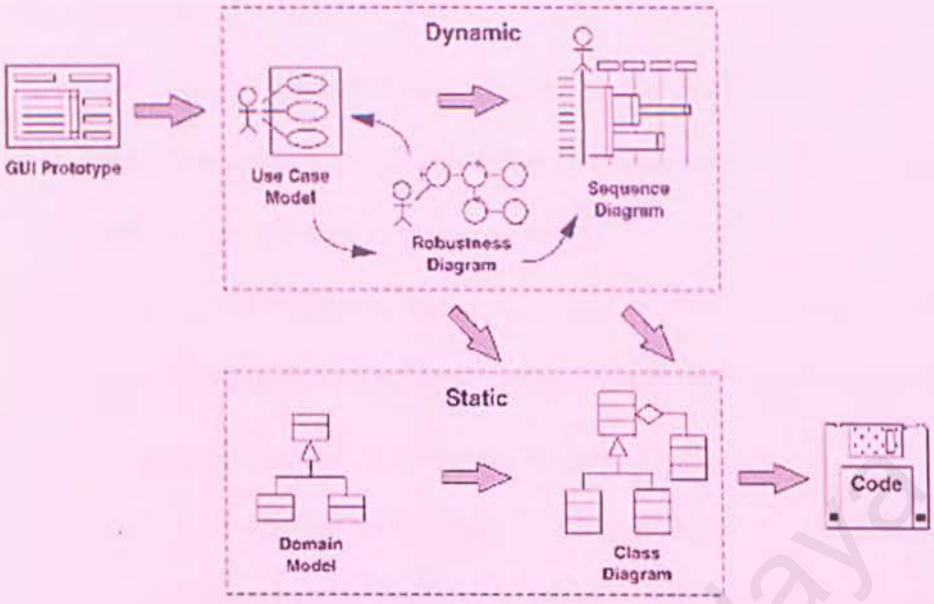


Figure 3.5 "Big picture" in ICONIX Process

The ICONIX Process has three significant features. First feature is ICONIX Process is an approach that offers streamlined usage of UML. This means minimal set of steps is needed for the successful object-oriented development project. The developer only needs to focus on a subset of large and unwieldy UML. Second feature is this approach offer a high degree of traceability. Along the development, developer can refer back to the requirement in some ways. Another feature is that it is an iterative and incremental approach. Multiple iterations will occur throughout the phases in the process.

3.2.3 Justification on Methodology

The Unified Process from the categories of object-oriented methodology has been chosen to model the development of car parking simulator. The decision is made due to the following advantages offered by Unified Process.

1) Use case driven

   a) Use case is expressed from the perspective of system's user which translates into a higher comfort level for customers, as they can see themselves reflected in the use case text.

   b) Use cases are expressed in natural language and offer a considerably greater ability for everyone to understand the real requirements on the system than typical requirements documents.

   c) Use cases offer the ability to achieve a high degree of traceability of requirements into the models that result from ongoing development.

   d) Use case offers a simple way to decompose the requirements for allocation of work into subsystem and facilitate project management.

2) Architecture centric

   a) Understanding of big picture – The architecture description facilitates an understanding of the architecture of the system being built.

   b) Facilitating the possibilities to reuse – A well constructed software architecture offers solid structure that on which component can reside and work with each other, while making it easy for teams building other systems to identify opportunities for possible reuse of any or all of those components.

   c) Evolving the system – The evolution of technologies and changing in business models will cause a system of any size and complexity subject to evolutionary changes. A solid architecture can prevent the regression fault from happen.

3) Iterative and incremental

a) Multiple opportunities offered for checking whether the software product is correct - This is because every iteration is incorporates with the test workflow.

b) The robustness of the architecture can be determines early in the life cycle - Every iteration will extends and changes the software product. The ability of the software product handles the extensions and changes prove the architecture is robust.

c) Risk can be mitigated early – Develop a software product incrementally can help in mitigate risk earlier in the life cycle.

d) Always has a working version of the software product. – The working version can be use by client for experimental to check whether the need are fulfilled and any changes are needed. Beside that, it also can smooth the introduction of new software product in the client organization.

3.3 Research Methodology

3.3.1 Information Gathering

Information gathering is an important element of software development. Effective information gathering method will ease the complexity in searching for useful information which was needed in the development process. The techniques below were used to collect information:

1) Internet sources

Internet surfing is the most effective and convenience way of information gathering. A lot of latest information regarding hardware technologies, new release software, existing system and related information can be found easily.

2) Books and references

The information like software development tool can be getting from the reference book. Besides that, faculty provides the senior's thesis report as a guideline and references.

3) Discussion with supervisor

Discuss with supervisor about the application domain for further understanding of the application domain. This will help in requirements gathering process.

4) Observation

Observation has been done on the road condition, parking slot and car. This information gathering techniques is useful as the system has to provide a realistic environment.

3.3.2 Analysis

The analysis technique that has been use in the analysis workflow is object-oriented analysis. It is a semiformal analysis technique. During this workflow, the classes of the system being developed are extracted.

The information gathered from different sources will be analyzed to identify its usefulness toward the development of the car parking simulator. The information which is lack of important will be eliminated. The process of information gathering and information analysis actually is an iterative and repeatable activity. As the information gathered analyzed and discover more information is needed for the development of the

system, the process of information gathering will be carry out for more information. These two processes are continuing until adequate information collected.

3.3.3 Design

Object-oriented method has been use to design the car parking simulator. Object-oriented approve have been chosen as the methodology as it is the most widely use and effective methodology among the others. Unified Modeling language (UML), object-oriented modeling language is chosen to illustrate the functionalities and flow of the events in the system. The diagrams that use includes use case diagram, activity diagram and state chart diagram.

3.3.4 Implementation

Implementation is the process of translating the details design into code. In implementation, the proposed system will develop based on the detail design by using the selected tools. Here is the stage where there will always be a working version that will be enhancing through iterative and incremental.

3.3.5 Testing

Testing has been carried out throughout the whole development process of the car parking simulator to ensure that the system delivered will fulfill the pre-defined requirements and objectives set are achieved. Testing should never treat as a separate workflow in the development process as late discovery of faults in the software will consume a large amount of money, time and effort to correct it. As the methodology chosen is Unified Process which testing workflow is carried out parallel with other workflow, the possibility of faults will be occur to the system can be reduce to minimum.

Chapter 4: System Analysis

4.1 System Requirement Analysis

Requirement is a statement of system functionality or constraints. Requirements can be divided into two categories; there are functional requirements and non-functional requirements. The requirements of the system's user are discovered and gathered during the requirements elicitation process. Once the initial set of gathered requirements have been drawn up, the process of requirements analysis will take place where the requirements will be refined and extended.

4.1.1 Functional requirements

Functional requirements specify the actions that the target product must be able to perform. The functional requirements address the quality characteristic of functionality. Below are the list of functional requirements of car parking simulator:

1) An unregistered user of the system can register to the system as a valid user to the system.

   A new/unregistered user needs to register before using the system. User will be presented by a registration form that require user to fill in his/her particular information. This registration system help in keep track on the record of the user who accesses the system. Through this registration system, all the information of the user will store in database for future usage. The registered user will has own user name and password which is use during the log-in process.

2) A registered user has to log in before performing any transaction in the system.

With the possessing of user name and password, user can log-in to the system through the log-in page. User need to log-in before having access to the system. This log-in process is to ensure that only valid user is allowed to access to the system.

3) User can simulate car parking. (User has to be logged-in before performing any transaction.)

A logged-in user can simulate car parking using mouse and keyboard. User who tends to simulate car parking has to choose on the type of parking in order to proceed. An environment regarding the criteria chosen will be created for the user. The simulation page will be displayed to the user. There will be several keys available to user that can be used to simulate car parking. The functions of the key include gear manipulation, engine starter, cultch, accelerator, movement and others. Will be a timer that help in calculate the time that needed by each user in parking the car into the parking slot. The time that achieved by the user will keep in database as a reference for comparison to see whether there are improvement in the time that needed to simulate a car.

4) User can view on the information that related to car parking. (User has to be logged-in before performing any transaction.)

A logged-in user can view the information related to the car parking. This functionality can help user in gaining knowledge about car parking.

5) User can view the previous result of simulation. (User has to be logged-in before performing any transaction.)

A logged in user can view the previous result of simulation to make a comparison between the previous and current result to see whether there are improvements in the duration of simulation.

6) User can generate report that listed the result of each simulation. (User has to be logged-in before performing any transaction.)

A logged-in user can print a report on the simulation result. The report will list out all the previous result on all type of car parking that simulated by user. Besides that, the report also will show whether there are improvements in the duration of simulation.

4.1.2 Non-functional requirements

Non-functional requirements define the overall qualities or attributes of the resulting system. It is a requirement which is not specifically concern with the functionality of the system. The purpose of the non-functionality requirements are to place restrictions on the software product being developed and the development process. Besides that, it also specifies the external constraints that the software product must meet. Non-functional requirements can be divided into 3 classes; there are process requirements, product requirements and external requirements.

Below is the list of non-functional requirements for car parking simulator that categorized by:

1) Product Requirements – Product requirements are requirements that specify the desired characteristics that must be possess by a system or subsystem. [29]

    a) Reliability

1. Availability – the system should be 98% available as it is web-based application that sometimes may face some technical problems like network busy and server down which prevent the application to be accessible by the user.
2. Failure Rate – the failure rate of the system should be 0%.

b) Performance

i. Response time – the system should response to the user request on the system functionality within 5 seconds.

c) Usability

i. User friendly – user should be able to use the system with ease. A well-structure user manual, informative error messages, help facilities and consistence user interface will definitely enhance the usability of the system. This will reduce the time that needed in the learning process of the system.

ii. Simplicity and attractiveness – a simplified user interface will make the system look uncluttered and simple. In the other hand, an attractive interface will make user more enjoyable and attractive in using the system.

d) Maintainability and expandability

i. The system should be easily adapted to the requirement changes and environment changes for modification and enhancement. This is important as future enhancements and expansion can be done easily.

e) Security

i. The data stored in the database shall only be access by the system administrator.

2) Process Requirements – Process Requirements are constraints on the development process of the system. [29]

a) The preparation of documents must be carrying out through out the development process for checking.

3) External Requirements – External Requirements are requirements which may be placed on the product and the process and which are derived from the environment in which the system is developed. [29]

a) The simulator shall be developed according to the real parking environment in Malaysia.

4.2 Hardware requirements

4.2.1 Server-side hardware requirements

Below are listed the minimum hardware requirements for server-side computer for optimum quality of development:

1) Processor – 300 MHz Intel Pentium Processor or equivalent (233 MHz is minimum required)
2) Memory – 64 MB of free available system RAM. (128 MB recommended) plus a minimum of 85 MB of available disk space (64 recommended)
3) Hard Disk – 20 GB of hard disk.
4) Input Device – Mouse and keyboard.
5) Output Device – Monitor with 1024 x 768 resolution, 16 bits display or better.
6) Other – Other computer peripherals being used such as speaker, CD-ROM and sound card.

4.2.2 Client-side hardware requirements

The hardware requirements of client side are quite minimal as long as the computer is able to connect to the internet with adequate RAM and reasonable fast modem.

4.3 Software requirements

Below are listed the software requirements for the car parking simulator:

1) Operating System / Platform– Any Microsoft Windows operating system
2) Browser – Internet Explorer 6

3) Flash Player (minimum version 6)

4.4 Tools and technology to be used

The following tools and technologies have been selected for the development of car parking simulator with some considerations.

4.4.1 Development Environment Tools

Microsoft Visual InterDev 6.0

Microsoft Visual InterDev 6.0 has been chosen as the development environment tool. It is a programming tool that include in the Microsoft Visual Studio. It supports the development of Microsoft Windows and web-based application. It is an ASP editor which can detect the syntax error easily and an easy to use development tools. Microsoft Visual InterDev 6.0 is able to create cross-browser solution. The browser can support both Internet Explorer 4.0 and later and Netscape Navigator 3.0 and later. It is an easy to use environment tool and able to detect the syntax error in the scripting language.

4.4.2 Programming Languages

VBScript

VBScript is chosen as the server side scripting language in the client server application.

JavaScript

JavaScript is chosen to serve as the client side scripting language in the client server application.

ActionScript

ActionScript is a scripting language that embedded in macromedia Flash MX. As Macromedia Flash MX has been chosen to develop the car parking simulator, ActionScript can help in manipulation of animation that can make it more interactive and interesting.

4.4.3 Software Program

Macromedia Flash MX

After review and evaluation on the advantages and disadvantages of the tools and technologies, Macromedia Flash MX has been chosen as the main tool to develop the system due to the following reasons:

1) Able to deliver high quality animation and audio.
2) No plug-in is needed for the viewing of the application created by the Macromedia Flash MX as it is supported by the browser.
3) Macromedia Flash MX enables file import into it to enhance the application quality.
4) Macromedia Flash MX is a vector-based program, where graphics are made up of simple lines formed by mathematic equation. The advantages of vector-based graphics includes:
5) Clarity and quality of graphics are maintained as it resize.
6) Fewer changes are required when the vector-based graphics changed in size or graphics, whereas bitmap increase the size.
7) Vector-based graphics is smaller than bitmaps graphics.

8) Platform independents - Macromedia Flash MX files are compatible to all platforms, such as Windows, Macintosh, Linux and Solaris.

9) Ability to run as a stand alone, offline application and web-based application.

10) For stand alone application, application can be built to nuclide both the application and its data and flash player.

11) For web-based application, application run on browser.

12) Browser independents – Macromedia Flash MX files are compatible to all browsers, such as Internet Explorer, Netscape Navigator, AOL 7 and Opera 6.

13) A multimedia platform which allow the embedded of videos, images, movies, sounds, mp3s and HTML files.

14) Flash embedded scripting language, ActionScript can be used for complex animation and interaction creation.

15) Debugger is provided for error checking.

16) The plug in, Flash Player that need to downloaded for Flash application playing includes broad support for major version of Windows, Solaris, Macintosh and Linux.

Adobe Photoshop 7.0

Adobe Photoshop 7.0 is chosen as an image creator and editor in the development of the system.

4.4.4 Platform

Microsoft Windows XP Professional

The platform that selected in the development of car parking simulator is Microsoft Windows XP Professional Edition. The selection of Windows XP is due to the following reasons:

1) The reliability of Windows XP Professional is higher if compared with other previous Microsoft Windows.
2) Simple design of Windows XP Professional's graphical user interface (GUI) makes it easier and faster to use.

4.4.5 Browser

Internet Explorer 6.0

The browser selected in the development of car parking simulator is Internet Explorer 6.0. The decisions made due to the following consideration:

1) It is the most widely use browser in the development of web-based application.
2) It is the most popular browser that using among the user.

4.4.6 Web server

Internet Information Server (IIS 6.0)

The web server that selected in the development of car parking simulator is Internet Information Server (IIS 6.0). IIS 6.0 is only available for Windows platform. The selection of Internet Information Server (IIS 6.0) is due to the following reasons:

1) It is a powerful web server that provides a high reliable, manageable and scalable web application.
2) It can help to increase web-sites and application availability while lowering system administrator cost.

3) Easier to administer because it is tightly integrated with the operating system.

4.4.7 Database

MySQL

The database that is using in the development of the system is MySQL database server. MySQL database server is the world's most popular open source database. It is free, possesses good support and has a lot of advantages. Below are the advantages of MySQL database server that make it as a choice for the development of system:

1) There is a graphical front for MySQL database called MySQL-Front. It is a front that can be use to contact directly with the database as it make the process of defining and managing the database structure, importing data and editing data simpler.
2) It has high degree of compatible as it can runs on any versions of Windows.
3) It is an easier and faster to use database server as there is a clearly structure menu prompt for the usage of user.

Chapter 5: System Design

System design defines as the appropriate selection and arrangement of system components, so as to meet the overall objectives and purpose of the system. [1] The activities that involved in the system design include:

1) Partition requirements – the requirement are analysed and collected into related groups.
2) Identify sub-systems – Different sub-systems that can individually or collectively meet the requirements are identified. Groups of requirements are usually related to sub-systems, so this activity and requirements partitioning may be amalgamated.
3) Assign requirement to sub-systems – the requirement are assigned to sub-systems.
4) The specific functions provided by each sub-system are specified.
5) Define sub-system interfaces – this involves defining the interfaces that are provided and required by each sub-system.

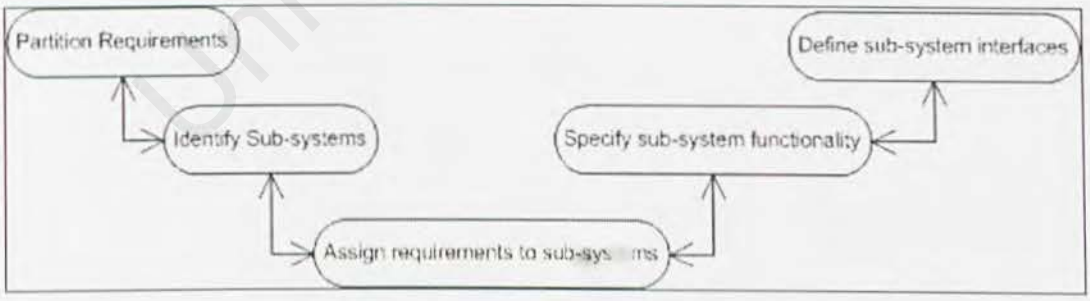


Figure 5.1: System Design Process

5.1 System Architecture

5.1.1 Overview of system architecture

The system architecture defines as following:

> "The documented, significant design decisions which taken together, describe the structure and behavior of a proposed or implemented system. The elements which are documented include the components which make up the system and the interfaces between these components, system usage, functionality, performance, resilience, and constraints and trade-offs." [2]

The concept of tier is using to group the different classes of architecture. There are four classes of system architecture; there are one-tier, two-tier, three-tier and n-tier.

5.1.2 Justification on System Architecture Selected

The system architecture selected for the development of car parking simulator is three-tier architecture as the system going to develop is a web-based application. Three-tier architecture consists of client-tier, application-server-tier and data-server-tier. Each tier has its own responsibilities:

1) Client-tier – This tier responsible for presentation of data, receiving user events and controlling user interface.
2) Application-server-tier – All the actual business logic are run in the application-server-tier. It responsible to protect the data from direct access by the clients.
3) Data-server-tier – This tier is responsible for data storage.

The boundaries between tiers are logical. It is possible to run all three tiers on the same machine. The important of system architecture is to make sure the system is neatly

structure and therefore there will be a well planned definition of the software boundaries between the different tiers.

The introduction of three-tier architecture is due to the problems that exist in the two-tier architecture. The problems of two-tier architecture include:

1) Fat-client problem- the problem of complete application logic runs in the client-tier lads to monolithic application which is very expensive to maintain.
2) Network load increased – data that store in the data server have to be transported over network for the processing of data which actually held in client-tier.
3) Security problems – the applications that run on the client are easily to crack. Besides that, the sensitive data is transfer to client.
4) The influences of change management are drastic – when there is a change in the application logic, all the clients needed to adapt to the new version of application logic.

The three-tier architecture has many advantages over the two-tier architecture. These advantages solve the problems that inheritance from two-tier architecture. The advantages include:

1) A clear separation between user interface control and data presentation from application logic. The benefits of the separation of client application are quicker development through the reuse of pre-built application components and shorter test phase.
2) The clients wouldn't influences by the re-definition of the storage strategy. In a well designed system, the clients access the data over a stale interface which encapsulates all the storages detail.

3) Security – The authorization of a single server is easier than a large number of clients. It is more logical to run critical business process that work with security sensitive data on the server than in client.

4) Change management is easier – It is faster to exchange a component on the server than furnish numerous clients with new version of programs.

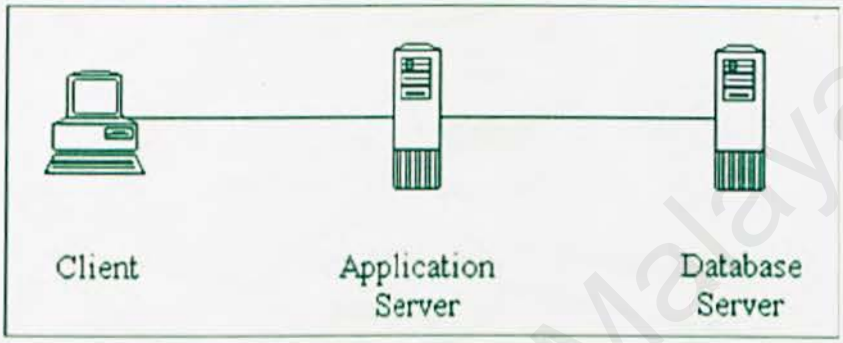


Figure 5.2: 3-Tier Client-Server Architecture

5.2 System Functionality Design

5.2.1 Use Case Diagram

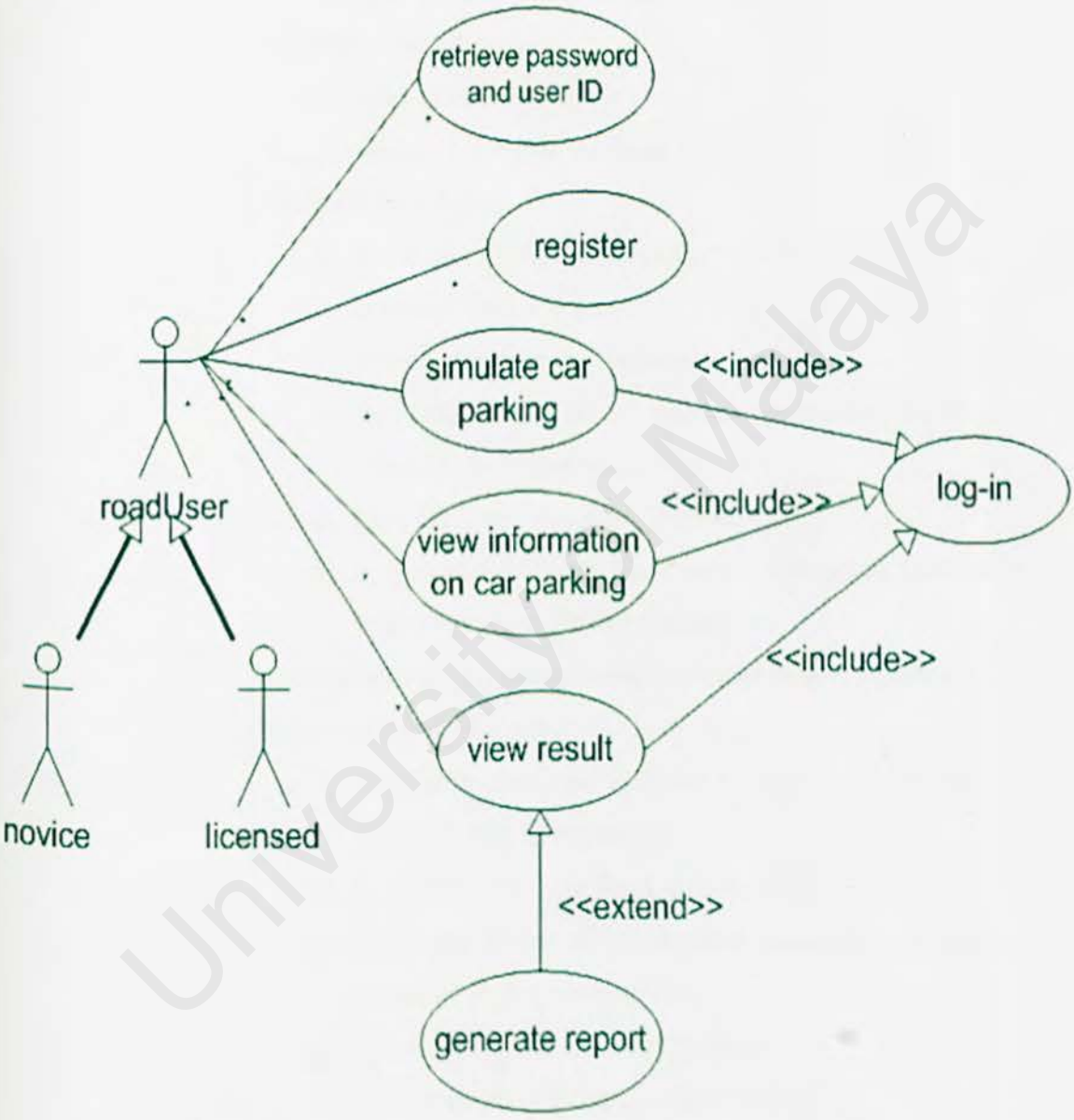


Figure 5.3: Car Parking Simulator Use Case Diagram

Below are the descriptions of each use case:

Table 5.1: Description of Register Use Case

Use Case	Description
Register	An unregistered user needs to register before he can log-in in order to perform simulation. Actor: Road User Pre-Condition: Unregistered Road User Main Flow of Event: 1) Road user clicks on "Register NOW" button or "free account" link to register. 2) System displays the Registration page. 3) Road user inserts all information needed into the fields provided in Registration Page. 4) User click on "Register" button. 5) Registration success. Road user is redirect to Simulation Page to perform further transaction. Post-condition: An unregistered road user is now registered. Alternate Flow of Event: 1) Road user clicks on "Register NOW" button or "free account" link to register. 2) System displays the Registration page. 3) Road user inserts all information needed into the fields provided in Registration Page. 4) Road user clicks on Reset "button". 5) All information filled is now clear. Post-condition: The information inserted is cleared. Alternate Flow of Event: 1) Road user clicks on "Register NOW" button or "free account" link to register. 2) System displays the Registration page.

	3) Road user inserts all information needed into the fields provided in Registration Page. 4) Road user clicks on Register button. 5) Registration failed. Error message will pop out and Registration Page will re-display in order to let user re-enter the information. Post-condition: An unregistered road user is still not registered.

Table 5.2: Description of Log-in Use Case

Use Case	Description
Log-in	A registered user needs to log-in before performing any transaction. Actor: Road User Pre-condition: A registered user that has not yet log in. Main Flow of Event: 1) Road user inserts user ID and password into the User ID: field and Password: field provided in Log-In Page. 2) Road user clicks on "Sign In" button. 3) Log in success. Road user is redirect to Simulation Page to perform transaction. Post-condition: Road user is now logged-in. Alternate Flow of Event: 1) Road user inserts user ID and password into the User ID: field and Password: field provided in Log-In Page. 2) Road user clicks on "Sign In" button.

	3) Log-in failed. The system will display the log-in failure message and road user is requiring to log-in again. Post-condition: Road user is not yet log-in. Alternate Flow of Event: 1) Road user inserts user ID and password into the User ID: field and Password: field provided in Log-In Page. 2) Road user clicks on the "Reset" button. All data filled are cleared. Post-condition: All data filled is cleared and reset.

Table 5.3: Description of Retrieve User ID and Password Use Case

Use Case	Description
Retrieve User ID and Password	A registered user who has forgotten his Password or User ID can retrieve it by using its IC number. Actor: Road User Pre-condition: A registered user. Main flow of Event: 1) Road user clicks on the "Forgot your User ID or Password?" link. 2) Road user insert the IC number into the IC Number: field provided. 3) Road user clicks on "Submit" button to retrieve. 4) Password and User ID retrieval are succeed. Post-condition: User ID and password are retrieved. Alternate Flow of Event: 1) Road user clicks on the "Forgot your User ID or Password?" link.

	2) Road user insert the IC number into the IC Number: field provided. 3) Road user clicks on "Submit" button to retrieve. 4) Password and User ID retrieval are failed. Post-condition: User ID and Password failed to retrieved. Alternate Flow of Event: 1) Road user clicks on the "Forgot your User ID or Password?" link. 2) Road user insert the IC number into the IC Number: field provided. 3) Road user clicks on the "Reset" button. All data filled are cleared. Post-condition: All data filled are reset and cleared. Alternate Flow of Event: 1) Road user clicks on the "Forgot your User ID or Password?" link. 2) Road user clicks on the "Login" button. Post-condition: Road user is redirect to Login Page.

Table 5.4: Description of Simulate Car Parking Use Case

Use Case	Description
Simulate Car parking	A logged-in road user can simulate car parking. (flash) Actor: Road User Pre-condition: A logged-in user. Main flow of Event: 1) Road user clicks on the "enter" button in flash movie. 2) System display Parking Type Selection Page. 3) Road user selects the parking type to simulate car parking. 4) Road user clicks on "start simulation" button. 5) System display Simulation Page for the parking type

	choused. 6) Road user starts the car parking simulation. 7) Road user continues simulate the car by using the keyboard key. (18 key) 8) Step 7 is continue as long as the road user is not yet successfully parks the car into the parking slot. 9) Result of the simulation is display. Post-condition: Road user success to park the car into the parking slot and the simulation result is displayed to road user. Alternate Flow of Event: 1) Road user clicks on the "enter" button in flash movie. 2) System display Parking Type Selection Page. 3) Road user selects the parking type to simulate car parking. 4) Road user clicks on "start simulation" button. 5) System display Simulation Page for the parking type choused. 6) Road user starts the car parking simulation. 7) Road user continues simulate the car by using the keyboard key. (18 key) 8) Road user hit the building along the road side. Post-condition: Road user's car crash with the building and error message is display. Alternate Flow of Event: 1) Road user clicks on the "enter" button in flash movie. 2) System display Parking Type Selection Page. 3) Road user selects the parking type to simulate car parking. 4) Road user clicks on "start simulation" button. 5) System display Simulation Page for the parking type choused. 6) Road user starts the car parking simulation. 7) Road user continues simulate the car by using the keyboard

	key. (18 key) 8) Road user hit the car already parked in the parking slot. Post-condition: Road user's car crash with the car parked in the parking slot and error message is display. Alternate Flow of Event: 1) Road user clicks on the "enter" button in flash movie. 2) System display Parking Type Selection Page. 3) Road user selects the parking type to simulate car parking. 4) Road user clicks on "start simulation" button. 5) System display Simulation Page for the parking type choused. 6) Road user starts the car parking simulation. 7) Road user continues simulate the car by using the keyboard key. (18 key) 8) Road user goes out from the boundary of the simulation area. Post-condition: Road user's car goes out from the simulation area and error message is display.

Table 5.5: Description of View Information on Car Parking Use Case

Use Case	Description
View Information on Car parking	A logged-in road user can view information on car parking. Actor: Road User Pre-condition: A logged-in road user. Main Flow of Event: 1) Road user clicks on the "Parking Information" button. 2) Road user can choose on either one information link to view the parking information. (5 links) Post-condition: The Information page with selected information displayed to road user.

Table 5.6: Description of View Result Use Case

Use Case	Description
View Result	A logged-in road user can view result of previous car parking simulation. Actor: Road User Pre-condition: A logged-in road user. Main Flow of Event: 1) Road user clicks on the "Simulation Result" button. Post-condition: The Simulation Result Page with previous result displayed to the road user. Alternate Flow of Event: 1) Road user clicks on the "Simulation Result" button. Post-condition: The Simulation Result Page with no record displayed to the road user.

Table 5.7: Description of Generate Report Use Case

Use Case	Description
Generate Report	A logged-in user can generate report on the simulation result. Actor: Road User Pre-condition: A logged-in road user that has been views the result. Main Flow of Event: 1) User clicks on the "Print Report" button. Post-condition: The report is generated to the road user.

5.2.2 Class Diagram

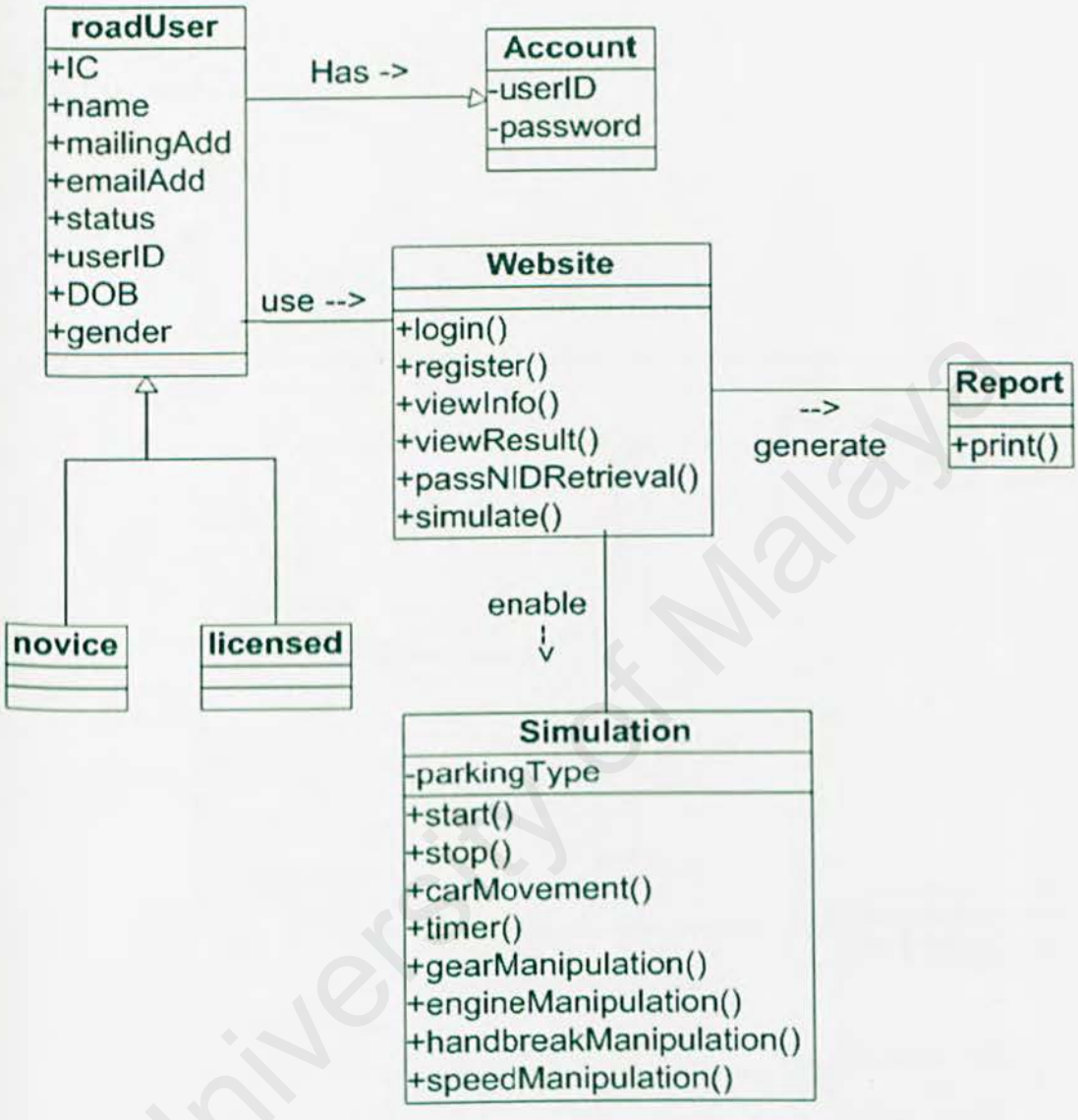


Figure 5.4: Car Parking Simulator Class Diagram

5.2.3 Activity Diagram

5.2.3.1 Use Case: Register

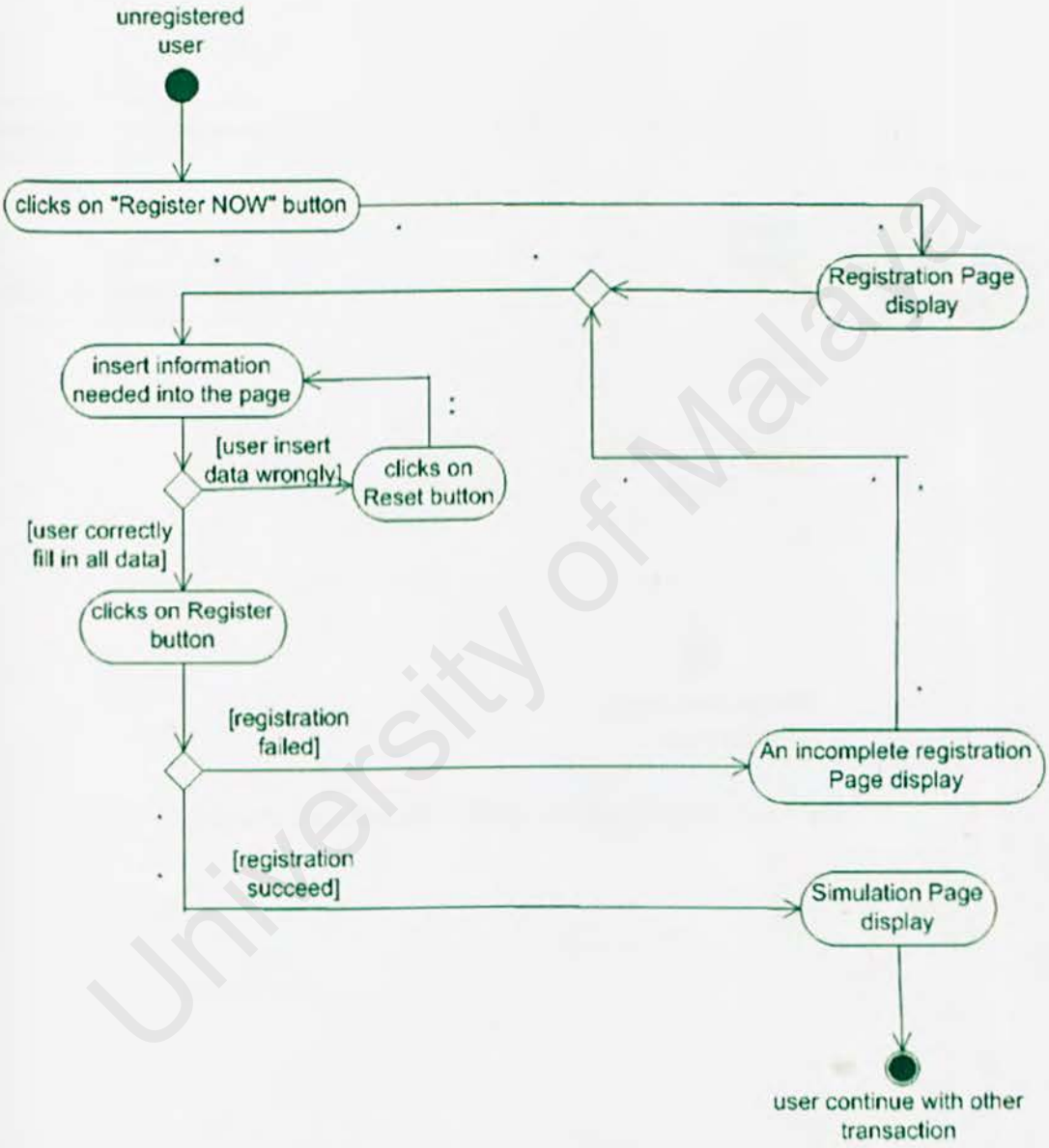


Figure 5.5: Activity Diagram for Register Use Case

5.2.3.2 Use Case: Log In

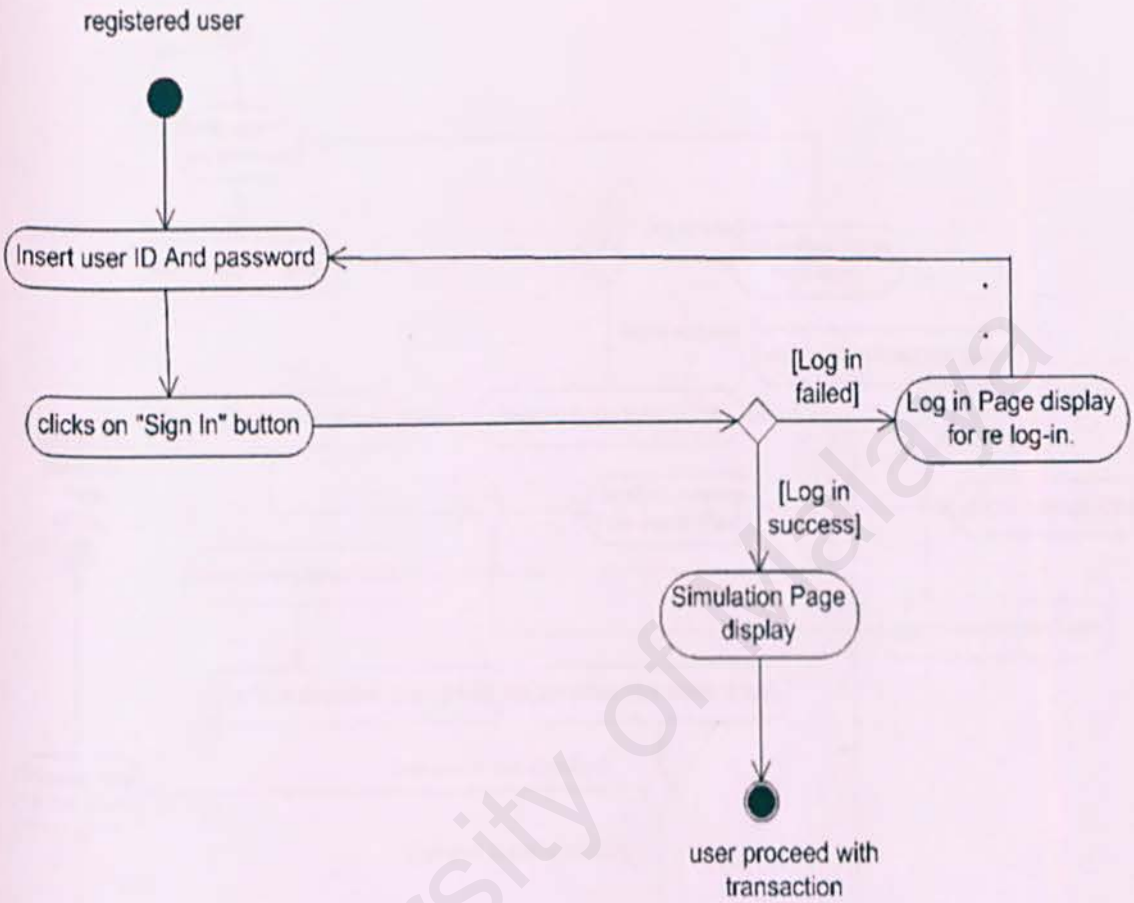


Figure 5.6: Activity Diagram for Log-In Use Case

5.2.3.3 Use Case: Simulate Car Parking

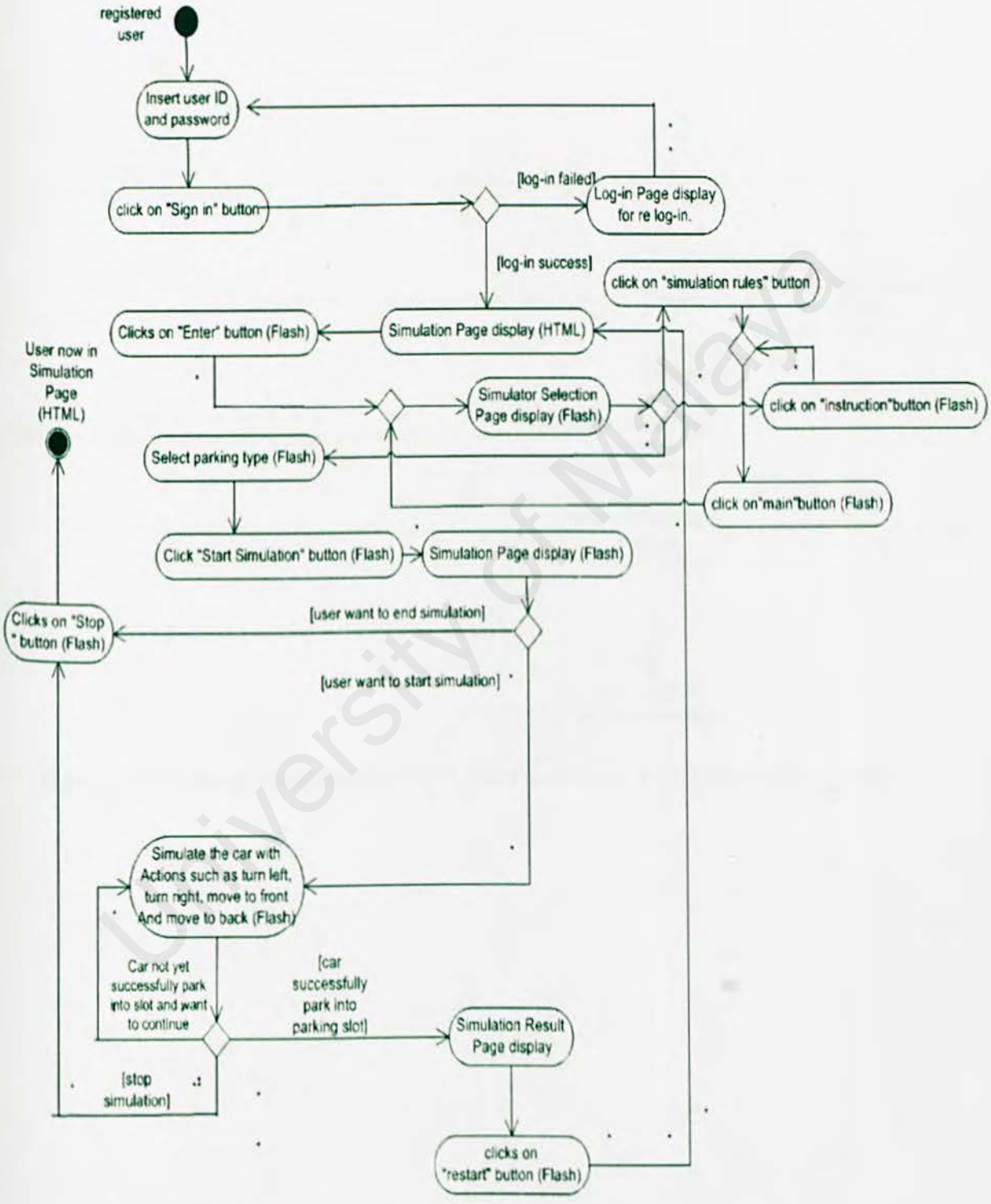


Figure 5.7: Activity Diagram for Simulate Car Parking Use Case

5.2.3.4 Use Case: View Information on Car Parking

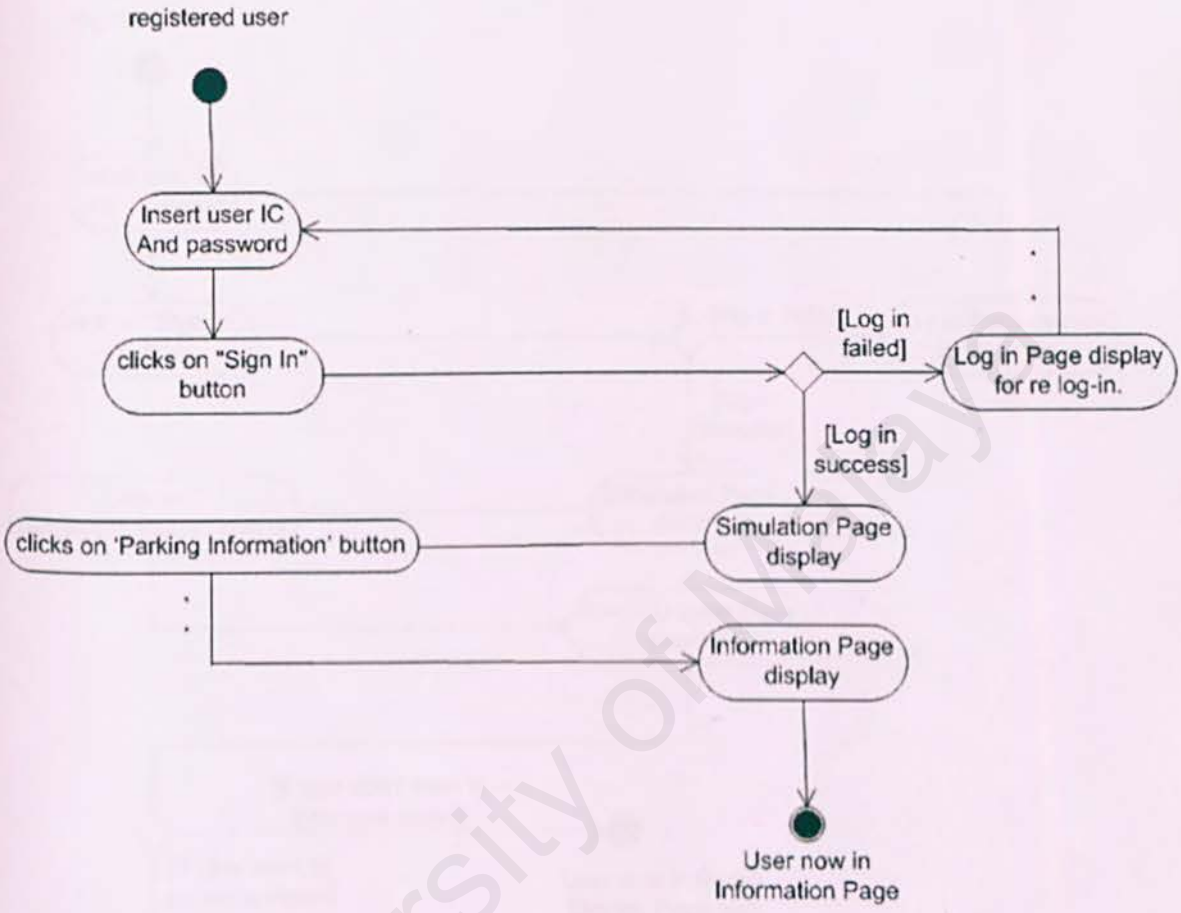


Figure 5.8: Activity Diagram for View Information on Car Parking Use Case

5.2.3.5 Use Case: View Result

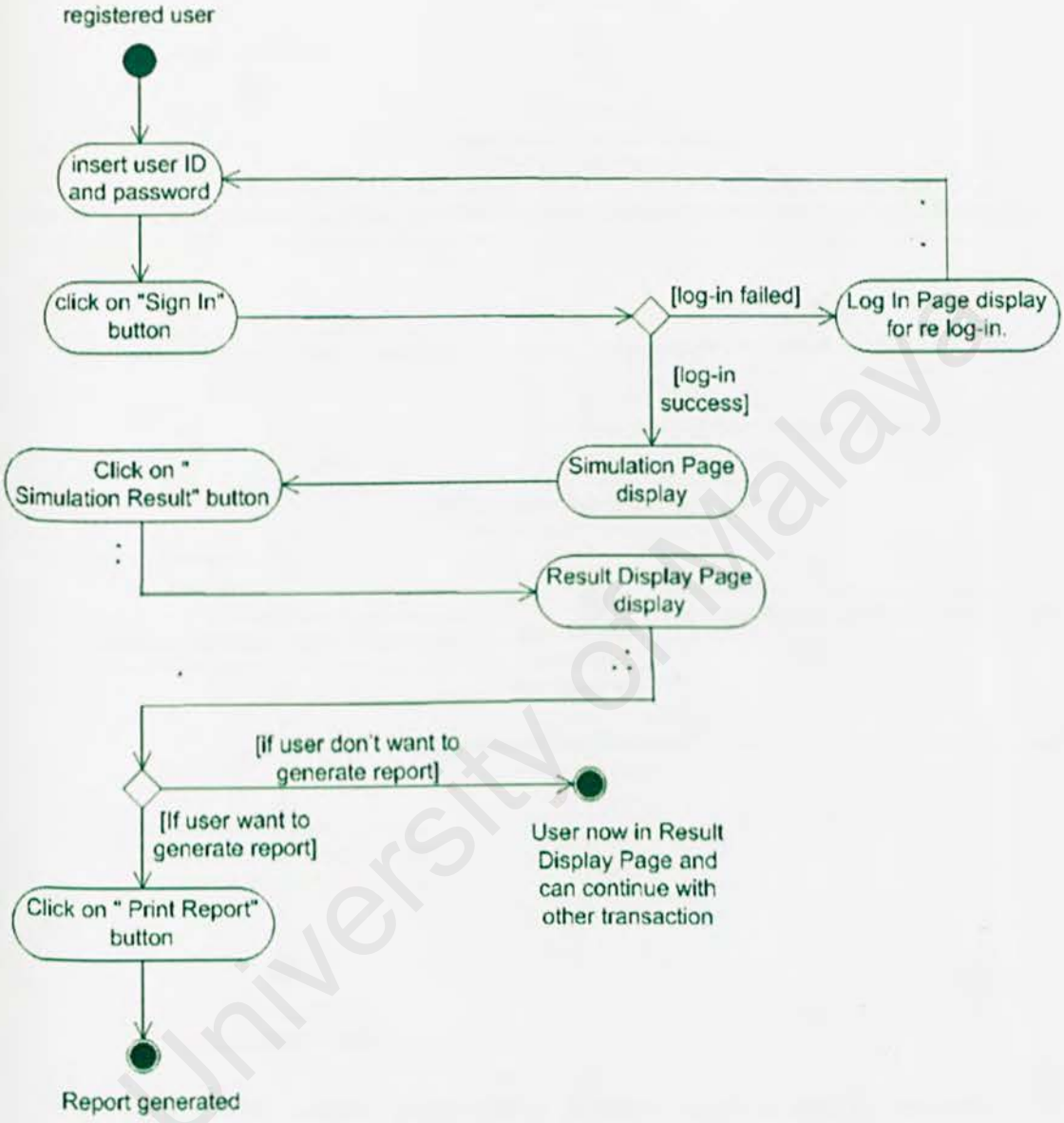


Figure 5.9: Activity Diagram for View Result Use Case

5.2.3.6 Use Case: Retrieve User ID and Password

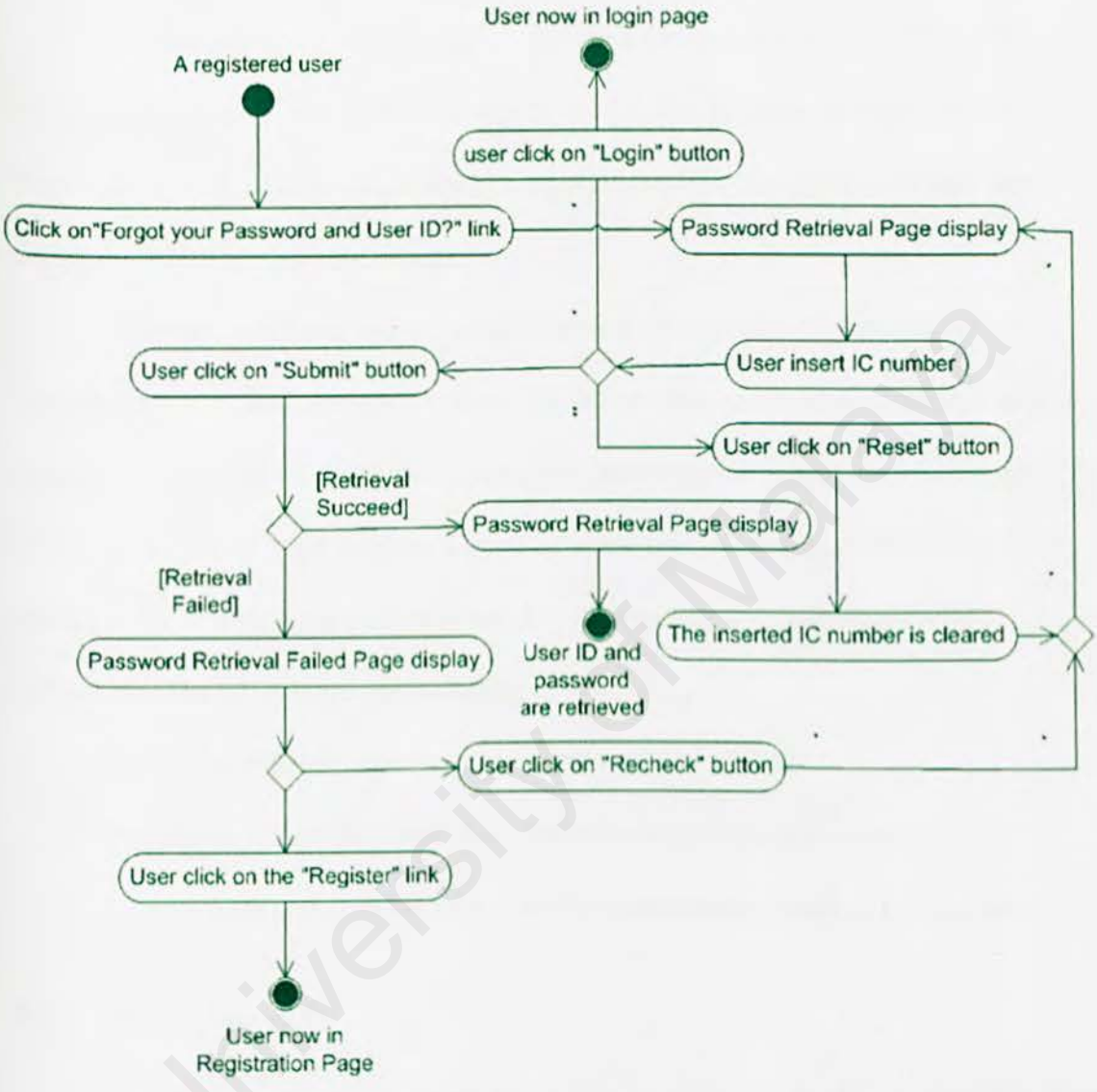


Figure 5.10: Activity Diagram for Retrieve User ID and Password

5.3 Database Design

Database design is the process of creating a design for a database that will support the enterprise operations and objectives. [3] The database design consists of three main phases. The phases include conceptual database design, logical database design and physical database design.

Database is defined as the shared collection of logically related data, and a description of this data, designed to meet the information needs of an organization. [3] Database is essential for data storage, updating and retrieval. A well-structure database is very important as it can produce a good database that can provide data retrieval service at the best possible performance. A well-structure database has several advantages. The advantages are including:

1) Provide an efficient storage, update and retrieval of data.
2) Be reliable where the stored data should have high integrity data.
3) Be adoptable and scalable to new and unforeseen requirement and application.

5.3.1 Data Dictionary

Data dictionary is a list of data about data. In other words, data dictionary is data that describe objects in the database and makes it easier for those objects to be accessed or manipulated. [3]

Table 5.7: user_account Table

Attributes	Data Type	Lengths	Description
userName (Primary Key)	varchar	20	The name that using by user to login.
password	varchar	20	The password that

			using by user to login.

Table 5.8: user_detail Table

Attributes	Data Type	Lengths	Description
Name	Text	50	Name of the user who register to simulator.
IC (Primary Key)	Varchar	12	IC number of the user.
DOB	Date	-	Date of birth of the user.
mailingAdd	Text	50	Mailing address of the user.
emailAdd	Text	50	Email address of the user.
status	Varchar	8	The status of user, whether novice or licensed.
userName (Foreign Key)	Varchar	20	The name that using by user to login.
gender	Varchar	6	Gender of the user registered.

Table 5.9: simulation_result Table

Attributes	Data Type	Lengths	Description
userName (Foreign Key)	varchar	20	The name that using by user to login.

simulationType (Foreign Key)	char	2	The type of simulation selected by user.
Date (Foreign Key)	datetime		Date when user simulate car parking.
duration	time	-	Duration that needed by user to park the car in to the parking slot.
improvement	char	1	'y' indicates has improvement in simulation duration and 'n' indicated no improvement.

5.3.2 E-R Diagram

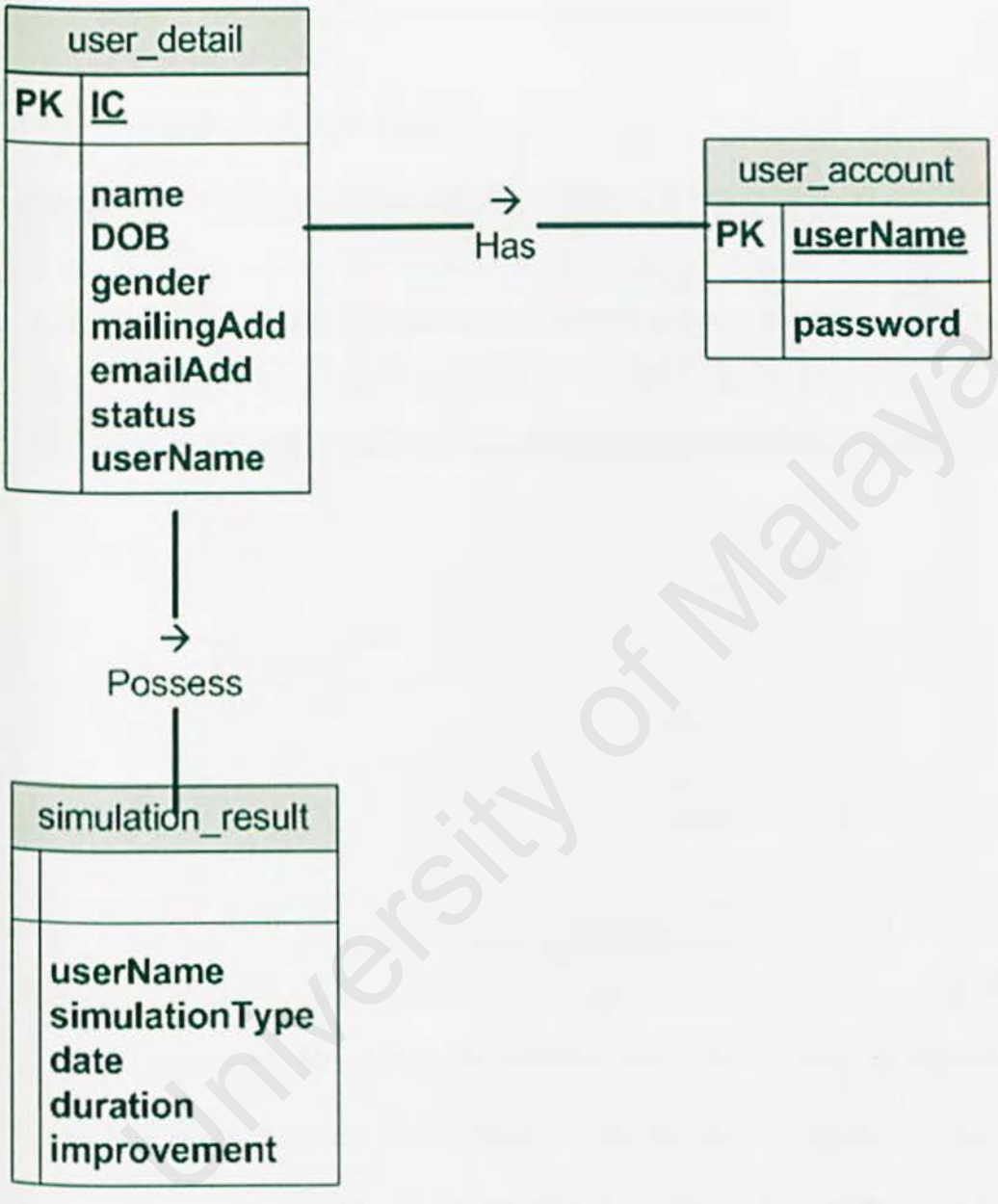


Figure 5.10: Entity Relationship Diagram for Car Parking Simulator

5.4 Interface Design

Below showed the interfaces design for Car Parking Simulator:

5.4.1 Home Page (Login Page)

Figure 5.11: Home Page (Log-In Page) for Car Parking Simulator

Figure 5.11 shows the Home Page that will display to user every time the web site is accessed by user. All registered users are required to log-in in order to gain access to the car parking simulator. In order to log-in, user needs to possess user ID and password. The user name and password are unique for every user. Users need to insert the user ID and password into the textbox provided and then click on the "Sign In" button in order to login. For those who currently not a registered member, they need to register. Users can either click on the "Register NOW" button or "free account" link provided in order

to register. Users also allowed to retrieve password or user ID in case they have forgotten by clicking the "Forgot your Password or User ID?" link.

5.4.2 Registration Page

Figure 5.12: Registration Page for Car Parking Simulator

Figure 5.12 shows the registration page of the system. This page is used by the unregistered user to register them to the web site. The user needs to fill in personal particular information which includes name, identity card(IC) number, gender, parking status, date of birth (DOB), mailing address, email address and status. Status indicates which category every user fall in. There will be either novice or licensed user. Besides that, users also required to fill in the login information which includes user name and password that will be used in the login process. Users are required to retype their

password as a way of validation that there is no typing error when users insert the password. Every registered user will hold a distinctive user name and password for the usage of log-in process.

5.4.3 Re Log-In Page

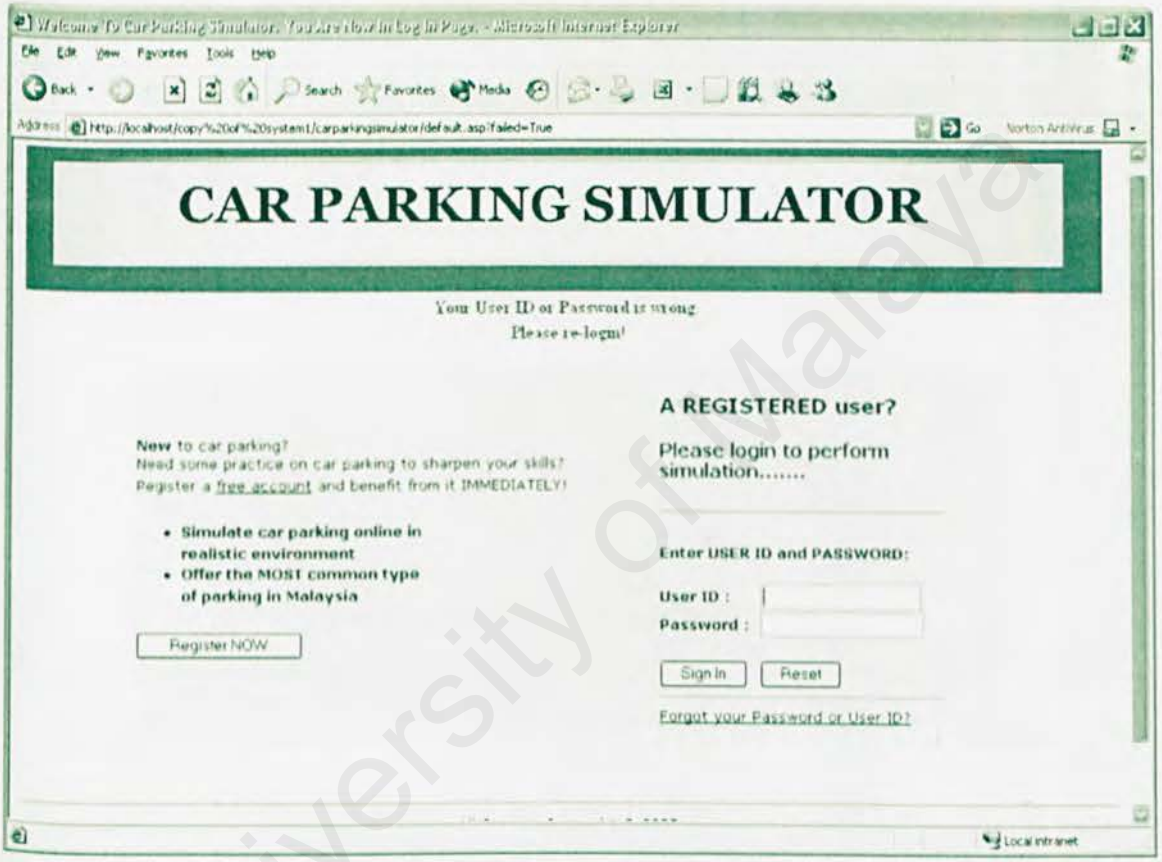


Figure 5.13 Re Log-In Page for Car Parking Simulator

Figure 5.13 shows the Re Log-In page that will display to user if the log-in process is failed. User is required to log-in once again. User is only allowed to access the web site when the log-in process is succeeded.

5.4.4 Password and User ID Retrieval Page

Figure 5.14 Password and User ID Retrieval Page for Car Parking Simulator

Figure 5.14 show the Password and User ID Retrieval Page. Users who forgot their password and user ID can retrieve it by using their IC number.

5.4.5 Simulation Page

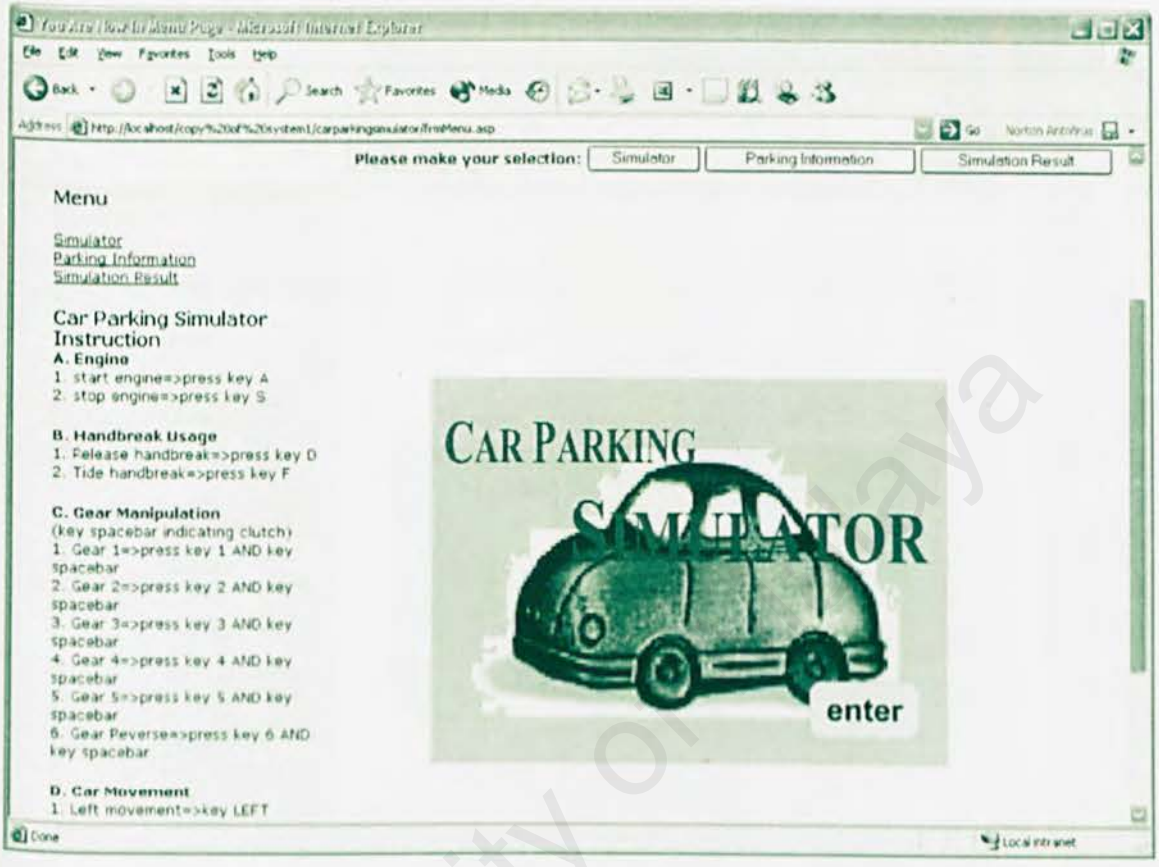


Figure 5.15: Simulation Page for Car Parking Simulator

Once the log-in is succeeding, user will be presented by this Simulation Page. In this Simulation Page, user can choose on what to perform. The user can simulate car parking, view information on car parking or view the simulation result.

5.4.6 Parking Information Page

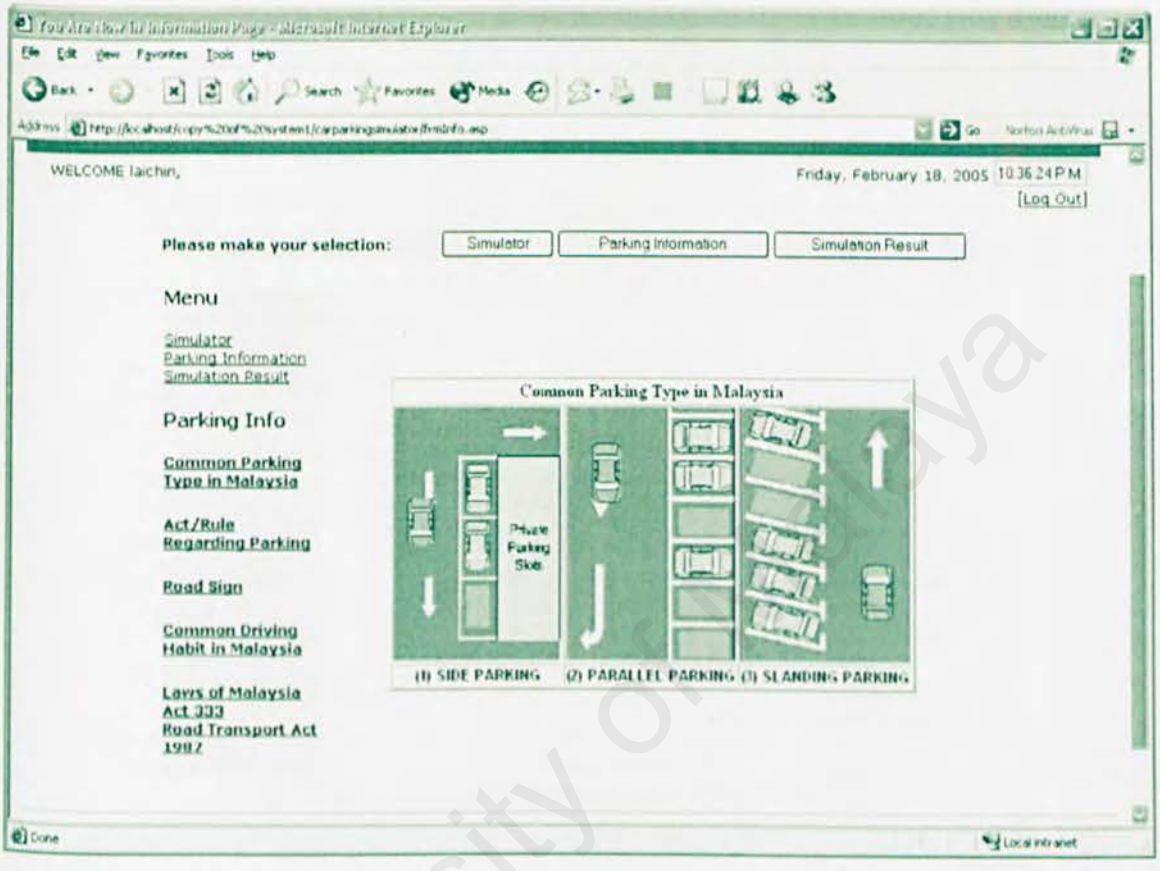


Figure 5.16: Parking Information Page for Car Parking Simulator

Figure 5.16 show the Parking Information Page. Users can gain extra knowledge and information about car parking by visiting this page.

5.4.7 Simulation Result Page

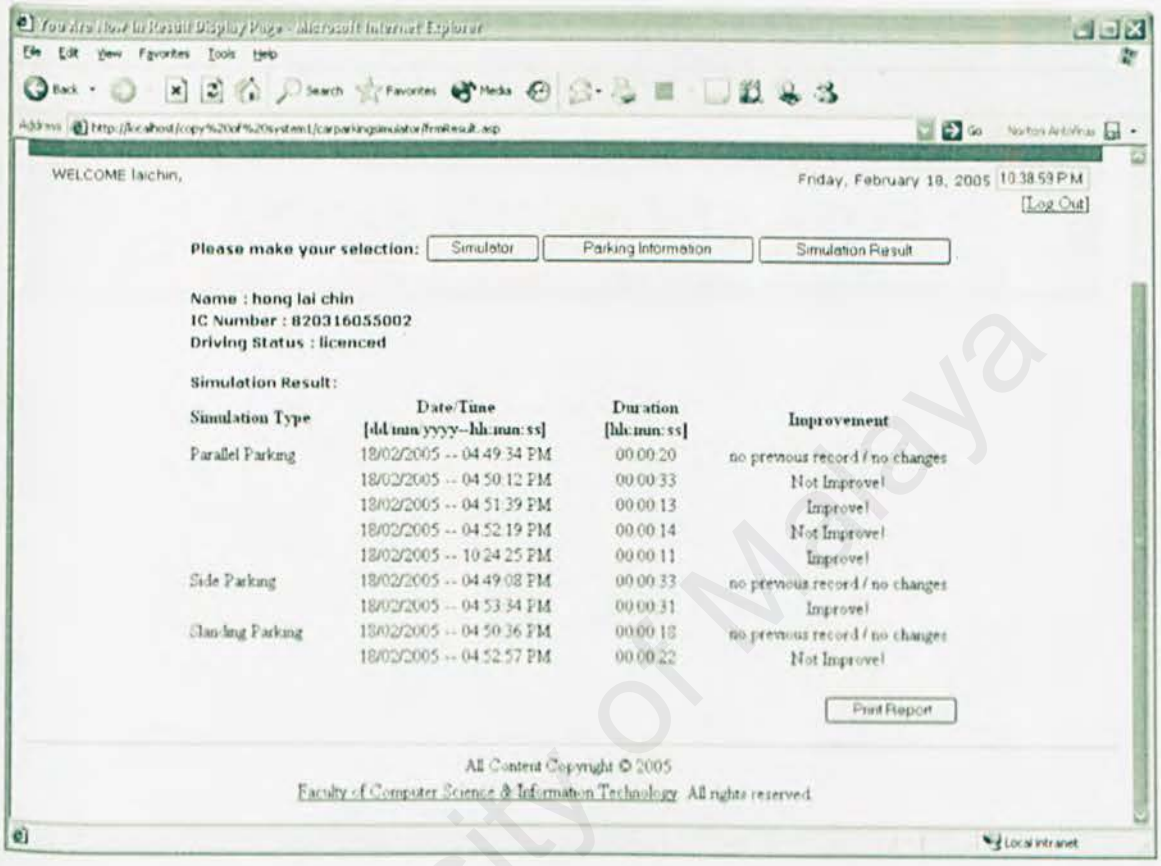


Figure 5.17: Simulation Result Page for Car Parking Simulator

Figure 5.17 show the Simulation Result Page. This result page will display all the previous result of the user in performing the simulation. Information included are simulation type, date/time of simulation, the result of simulation and improvement.

5.4.8 Log Out Page

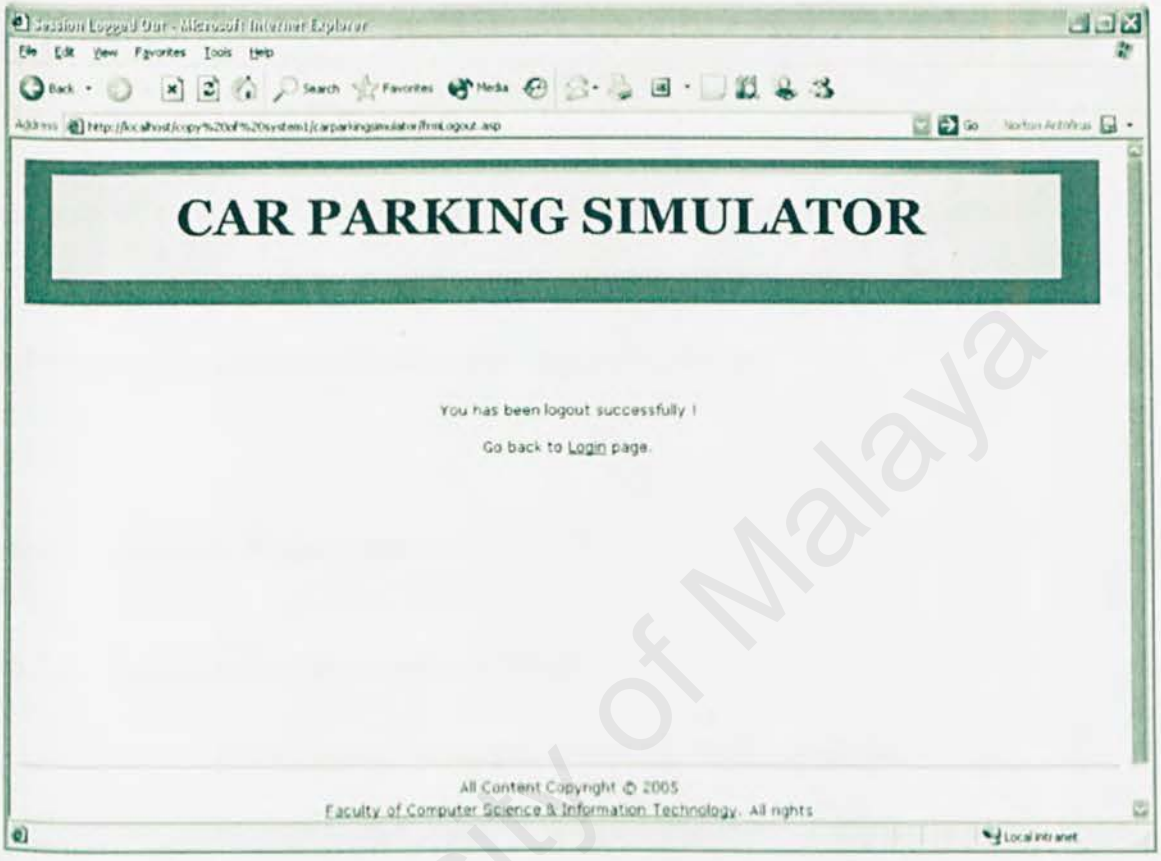


Figure 5.18: Log Out Page for Car Parking Simulator

Figure 5.18 show the Log Out Page. Users will be redirecting to this page when they log out successfully.

Chapter 6: System Implementation

6.1 Introduction

System implementation is the integration and incorporation of the physical and conceptual resources that produce a working system. Or in another word, system implementation is the process of translating the detailed design into code. It is the physical realization of the database and application designs.

6.2 System Requirements

6.2.1 Functions of Development Tools

Tools/Software use for development includes those means for:

a) Operating System – Microsoft Windows XP Professional.

b) Coding Development Tools – Ms Visual Interdev 6.0 and Macromedia Flash MX.

c) Graphics Design tools – Macromedia Flash MX, Ms Office Visio 2003 and Adobe Photoshop 6.0.

d) Browser – Internet Explorer 6.0

6.2.2 Program Coding Tools

a) Ms Visual Interdev 6.0

This is the platform where HTML, JavaScript and VBScript were created.

b) Macromedia Flash MX

Here is the place where Action Script 1.0 (programming language of Flash MX) is created.

6.2.3 Database Implementation Tools

a) MySQL

Here is the place where the database used for the system is created.

6.2.4 Graphics Creation Tools

a) Macromedia Flash MX

It is used to develop the car parking simulator which is the main part of the system.

b) Ms Office Visio 2003 and Adobe Photoshop 7.0

Part of the graphics that used for the system development is created by using these two tools.

6.3 Platform Development

6.3.1 Setting Microsoft Windows XP Professional

a) Firstly, the Microsoft Windows XP Professional with service pack 1 was installed.

b) Secondly, the IIS 6.0 was installed.

c) Thirdly, the Microsoft Visual Studio 6.0. (With Microsoft Visual Interdev 6.0) was installed.

d) Then, the Macromedia Flash MX, Adobe Photoshop 7.0 and Microsoft Office Visio 2003 were installed.

e) Lastly, the MySQL-4.0.22-win, MyODBC version 3.51.10.0 and MySQL-Front version 2.4 were installed.

6.3.2 Setting Database (MySQL)

After the database has been successfully installed to the server, a database named "carparkingsimulator" was created. Then the tables of the database which consists of "siulation_result", "user_account" and "user_detail" were created according to the database design done before. This database created will become the data storage of the system.

6.3.3 Configure Internet Information Server (IIS 6.0)

After installing the IIS 6.0, the virtual directory was created so that the user can access the application. The user can access the application through the following address.

http://servername/carparkingsimulator/default.asp

6.4 System Coding

6.4.1 Coding Methodology

The coding methodology that was used is top down methodology. The top-down methodology entails the development of the simple modules first followed by the complex module. By applying this methodology, the coding for the login module was done first, followed by the modules that are more complex.

The purpose of using the top-down methodology is to enable tests to be done on the simple module while the complex modules are still in the process of coding. Besides that, completing the simple modules first enable us to check whether the flows of the

system are the same as designed and the connectivity of each of the pages can be seen clearly.

6.4.2 Coding Style

The coding style is a very important attribute to determine the readability and maintainability of the source codes. With a clear and systematic coding style, it helps the programmer to see the codes easier in maintaining and also debugging and testing the system.

Following are the coding styles being implemented in the developing of the system:

a) Use of consistent and meaningful variables names

By using consistent and meaningful variables name, reference can be done easily. Below is the example:

- In the following example, the variables name "txtUserID", "txtPassword" and "txtPasswordRetype" are used to represent the user ID, password and password confirmation that inserted by the user when registration. The variables are consistent as all the variables are preceding by "txt" indicating that it is a variable for the textbox. The variables also meaningful as it is can be recognized easily.

```
<HTML>
<TR>
        <TD><font color="#oo3c5e" size="2" face="Verdana,
```

```
Arial, Helvetica, sans-serif">User ID:</font></TD>
        <TD><INPUT type="text" name="txtUserID" size=20
maxLength=20 ><font color=OrangeRed>*</font><font
color="#oo3c5e" size="2" face="Verdana, Arial, Helvetica,
sans-serif">must more than 6 char</font></TD>
</TR>
<TR>
        <TD><font color="#oo3c5e" size="2" face="Verdana,
Arial, Helvetica, sans-serif">Password:</font></TD>
        <TD><INPUT type="password" name="txtPassword"
size=20 maxLength=20><font
color=OrangeRed>*</font></TD>
</TR>
<TR>
        <TD><font color="#oo3c5e" size="2" face="Verdana,
Arial, Helvetica, sans-serif">Password
Confirmation:</font></TD>
<TD><INPUT type="password" name="txtPasswordRetype"
size=20 maxLength=20><font
color=OrangeRed>*</font></TD>
</TR>
```

b) Write comments or descriptions in the source code

The source codes with comments or descriptions will ease the process of the maintainability in further enhancement as the readability of the source codes will be increased by the comments. Below is the example:

- In the following example, ' tag is using to indicates comment in VBScript. It not only helps the development programmer but also the maintenance programmer for better understanding of the sources codes.

```
<VBScript>
'parking type checking for display → comment
If strType(i) = "si" Then
        strType(i) = "Side Parking"
ElseIf strType(i) = "sl" Then
        strType(i) = "Slanding Parking"
ElseIf strType(i) = "pa" Then
        strType(i) = "Parallel Parking"
 End If
```

c) Indents the code according to functional segments

The indention of code makes it easily visible to the programmer. Below is the example:

- In the following nested if statement, indention is very important for readability.

```
<VBScript>
```

```
If i = 0 Then
        Response.Write "<TD align=left>" & strType(i) &
"</TD>"
ElseIf i > 0 Then
        If strComp(strType(i), strType(i-1), 1) = 0 Then
                Response.Write "<TD align=left>" & " " &
"</TD>"
        Else
                Response.Write "<TD align=left>" & strType(i)
& "</TD>"
        End If
End If
```

d) Write an include file that contain reusable functions to reduce system size and coding time. Below is the example:

- The following include file was included in each page of the system that need to use the functions have been defined.

```
<VBScript>
<!-- #include file="../Includes/mod_database.asp" -->
```

e) Error handling implemented in the coding practice in order to make sure the system handle exception gracefully. Below is the example:

- In the following example, user will redirect to error page if the connection opening is failed.

```
<VBScript>
'functions to open connection with database
Function OpenConnection
Err.Clear
On Error Resume Next
Set cnProject = Server.CreateObject("ADODB.Connection")
        cnProject.ConnectionString =
DATABASE_CONNECTION_STRING
        cnProject.Open
        If Err.Number = 0 Then
            OpenConnection = True
        Else
            OpenConnection = False
            Response.Redirect "frmError.asp?ErrCode=2"
        End If
End Function
```

6.4.3 Coding Approach

Active Server Page

a) Function to check the validity of the user try to log in.

```
<VBScript>
'function to check the validity of the user who log in
Function CheckValidUser (strUserID, strPassword)
        Err.Clear
        On Error Resume Next
        Dim strSQL
        strSQL = "SELECT * FROM user_account WHERE userName ='" &
strUserID & _  "' AND password = ENCODE('" & strPassword & "' ,'fsktm')"
        ' encoding key is "fsktm"
        CheckValidUser = False
        If OpenConnection Then
            If OpenRS(strSQL) Then
                If NOT rsProject.EOF Then
                        Session("UserID") = strUserID
                        CheckValidUser = True
                End If
                CloseRS
            End If
        CloseConnection
        End If
End Function
```

b) Function to insert the data into the database when user registration.

```
Dim sSQLDetail
sSQLDetail = "INSERT INTO user_detail (IC, name, mailingAdd, emailAdd,
status, userName, DOB, gender) VALUES ('" & FixForSQL(ic) & "','" &
FixForSQL(name) & "','" & FixForSQL(add) & "','" & FixForSQL(emailAdd) &
"','" & FixForSQL(status) & _ "','" & FixForSQL(userID) & "','" &
FixForSQL(dob) & "','" & FixForSQL(gender) & "')"
IF OpenConnection THEN
        IF ExecuteSQL(sSQLDetail) THEN
                CloseConnection
        ELSE
                CloseConnection
        END IF
END IF
Dim sSQLAccount
sSQLAccount = "INSERT INTO user_account (userName, password) VALUES ('"
& FixForSQL(userID) & "', ENCODE('" & FixForSQL(pw) & "' ,'fsktm'))"
IF OpenConnection THEN
        IF ExecuteSQL(sSQLAccount) THEN
                CloseConnection
        ELSE
                CloseConnection
        END IF
END IF
```

```
Response.Redirect("Default.asp")
```

c) Function to retrieve simulation result from database for display.

```
strSQL = "SELECT simulationType, simulationDate, improvement, hour(duration)
as hour, minute(duration) as minute, second(duration) as second FROM
simulation_result WHERE userName = '" & userID & "' ORDER BY
simulationType, simulationDate"
If OpenConnection Then
        recordNum = 0
        If OpenRS(strSQL) Then
            WHILE NOT rsProject.EOF
                Redim Preserve strType(recordNum)
                Redim Preserve simulationDate(recordNum)
                Redim Preserve sHour(recordNum)
                Redim Preserve sMinute(recordNum)
                Redim Preserve sSecond(recordNum)
                Redim Preserve improve(recordNum)
                strType(recordNum) = rsProject("simulationType")
                simulationDate(recordNum) = rsProject("simulationDate")
                sHour(recordNum) = rsProject("hour")
                sMinute(recordNum) = rsProject("minute")
                sSecond(recordNum) = rsProject("second")
               improve(recordNum) = rsProject("improvement")
```

```
            rsProject.MoveNext
            recordNum = recordNum + 1
        WEND
        CloseRS
        End If
        CloseConnection
End If
```

Action script 1.0 (Flash MX)

a) Car Movement

```
//turns the car anti-cloclwise
if (Key.isDown(Key.LEFT)) {
        rotateLeft += (speed / 50);
        pressLeft = 1;
}
// turns the object clockwise
if (Key.isDown(Key.RIGHT)) {
        rotateRight += (speed / 50);
        pressRight = 1;
}
// calculates the direction of the object and moves it forward
if (Key.isDown(Key.UP) && reverse == 0) {
```

```
        if(pressLeft == 1 && speed != 0){
                _root.mCar1._rotation -= rotateLeft;
                pressLeft = 0;
        }else if(pressRight == 1 && speed != 0){
                _root.mCar1._rotation += rotateRight;
                pressRight = 0;
        }
        _root.mCar1._x +=speed*Math.sin(_root.mCar1._rotation*Math.PI/180);
        _root.mCar1._y -= speed*Math.cos(_root.mCar1._rotation*Math.PI/180);
}
// calculates the direction of the object and moves it forward
if (Key.isDown(Key.DOWN) && reverse == 1) {
        if(pressLeft == 1 && speed != 0){
                _root.mCar1._rotation -= rotateLeft;
                pressLeft = 0;
        }else if(pressRight == 1 && speed != 0){
                _root.mCar1._rotation += rotateRight;
                pressRight = 0;
        }
        _root.mCar1._x -= speed*Math.sin(_root.mCar1._rotation*Math.PI/180);
        _root.mCar1._y += speed*Math.cos(_root.mCar1._rotation*Math.PI/180);
}
```

b) Gear manipulation (For example gear 1)

```
//key 1(49) indicates gear 1
if(Key.isDown(49) && Key.isDown(32) && startEngine == 1 && handbreak ==
1){  //key spacebar indicates clutch
        maxVelocity = 3;
        if(reverse == 1){
                speed = 0;
                gear = 1;
                reverse = 0;  //  to free the reverse gear
        }
        if(gear == 0 && reverse == 0){
                gear = 1;
        }else if(gear == 2){//from gear 2 slow down to gear 1
                gear -= 1;
        }
}
```

c) Function to detect crash between user's car and car parked in the parking slot (Example for parallel parking)

```
for(i=1; i<=7; i++)
{
        if(_root.mCar1._x > _root["sCar" + i]._x)
                sideDistance_x[i] = _root.mCar1._x - _root["sCar" + i]._x;
        else
```

```
                sideDistance_x[i] = _root["sCar" + i]._x - _root.mCar1._x;
        if(_root.mCar1._y > _root["sCar" + i]._y)
                sideDistance_y[i] = _root.mCar1._y - _root["sCar" + i]._y;
        else
                sideDistance_y[i] = _root["sCar" + i]._y - _root.mCar1._y;
sideWidthCar[i] = (_root.mCar1._width/2) + (_root["sCar" + i]._width/2);
sideArea[i] = Math.pow((((_root.mCar1._height/2 + _root.mCar1._width/2)/2) +
((_root["sCar" + i]._height/2 + _root["sCar" + i]._width/2)/2)), 2);
sideFlagCar = (((sideDistance_x[i] * sideDistance_x[i]) + (sideDistance_y[i] *
sideDistance_y[i])) < sideArea[i]);
        if(sideFlagCar){
                crashCar = true;
                crashSound.start();
                gotoAndPlay("Crash", 1);
        }
}
```

d) Function to check whether the user car has been parked properly. (Example Parallel Parking)

```
//to check whether the car has parked into the parking slot
if(parked1 || parked2 || parked3 || parked4 || parked5){
        if(sStop){
                //sStop = false;
```

```
        }else{
                timerStop();
                if(parked1){
                        parked1 = false;
                }else if(parked2){
                        parked2 = false;
                }else if(parked3){
                        parked3 = false;
                }else if(parked4){
                        parked4 = false;
                }else if(parked5){
                        parked5 = false;
                }
        }
}
```

6.5 Summary

In system implementation phase, nearly all the design phases that have been presented and directed toward a final objective that needs to translate representation of system into a form that can be understood by computer. Overall, the primary goal of this phase is to produce a simple, clear source code with internal documentation that will ease the processes of a verification, debugging, testing, modification and further enhancement.

Chapter 7: System Testing

7.1 Introduction

Testing is a process of executing a program with the intent of finding error in the system. By performing testing process, the absence of the defects cannot be show; it is only manage to show that the software defects are present. The objective of the testing process is to uncover the logical errors and to test the system reliability. The purposes of the testing process include: [30]

a) To ensure that all functionality of the system behavior as intended.

b) To ensure that the internal operation of the system perform according to specification and all internal components has been adequately exercise.

c) To ensure that the system is free from defects and errors

Black box (functionality) testing has been carried out through out the testing process. By implementing black box testing, bugs were identified only according to software malfunctioning as they are revealed in it erroneous output. If the outputs were correct, internal path of the coding will disregards. [31]

There are several stages involve in the system testing process, there are unit testing, integration testing and system testing.

a) Unit Testing

b) Integration Testing

c) System Testing

7.2 Unit Testing

Unit testing is the first stage of testing where each component of the system is tested on its own, isolated from other component in the system. Unit testing will check each module of the system for the presence of the errors or bugs. The purpose of unit testing is to make sure that each developed module behaves according to its specification defined during the design process.

Unit testing concentrate on the smallest unit of the software program, which is call module. A module is consists of a collection of component, which is independent. The interaction between unit components is tested after each unit component has been tested. For example, in user registration module of "The Car Parking Simulator", consists of few sub-module like data insertion into database, data retrieval from database and data capturing from the user insertion. All these sub-module are tested to guarantee it is error freed. The unit testing was carried out at the end of the module development, but not at the end of the system development. This can reduce the cost of debugging.

The code was debugging to identify and remove any coding faults. Because of there are no proper and suitable debugger and tester can be using for ASP, "Response.write" command was used to verify the correctness of the data inputted and outputted. Below is the testing being done:

Active Server Page (ASP)

For Example:

```
<VBScript>
<%
Dim exist : exist = false  'indicate the user ID not existing
```

```
sSQLConfirm = "SELECT userName FROM user_account WHERE userName = '" &
FixForSQL(userID) & "'"
Response.Write sSQLConfirm
Response.end
If OpenConnection Then
        If OpenRS(sSQLConfirm) Then
            If NOT rsProject.EOF Then
                exist = true
            End If
            CloseRS
        End If
        CloseConnection
End If
%>
```

"Response.write" command was used to check whether the SQL statement is correct. "Response.end" command was used to end the execution of the program in order the SQL statement can be print out before redirect to other page.

Other units there were unit tested were:

a) Opening and closing of database connection.

For example:

```
<VBScript>
<%
```

```
Set cnProject = Server.CreateObject("ADODB.Connection")
cnProject.ConnectionString = DATABASE_CONNECTION_STRING
cnProject.Open
%>
```

b) Opening and closing of recordset.

For example:

```
<VBScript>
<%
Set rsProject = Server.CreateObject("ADODB.RecordSet")
rsProject.Open strSQL, cnProject, 0, 1, 1
%>
```

c) Insertion of new record into database.

For example:

```
<VBScript>
<%
Set cmdProject = Server.CreateObject("ADODB.Command")
With cmdProject
        .ActiveConnection = cnProject
        .CommandText = strSQL
        .CommandType = 1
        .Execute
End With
%>
```

d) Retrieve record from database.

e) Validation of user ID and password when log in session.

f) Execution of SQL statement.

g) Normal data test. - Test by using normal data to check whether the system works properly under normal situation.

h) Extreme data test. - Test with invalid data (fault email address format, input non-numerical data into a numerical field) that is not supported by the input field.

Action Script 1.0 (Flash MX)

For Examples:

a) Gear manipulation – testing has been carried out to test whether the gear was perform as expected.

```
//key 2(50) indicates gear 2
if(Key.isDown(50) && Key.isDown(32) && startEngine == 1 && handbreak == 1){
        maxVelocity = 6;
        if(gear == 1){
                gear += 1;
        }else if(gear == 3){//from gear 3 slow down to gear 2
                gear -= 1;
        }else if(gear == 4 || gear == 5){//from gear 4 slow down to gear 2
                gear -= 2;
        }
}
```

b) Car movement – the code has been tested to check whether the movement of the car is smooth and move correctly regarding the key being pressed.

```
// calculates the direction of the object and moves it forward
if (Key.isDown(Key.UP) && reverse == 0) {
        if(pressLeft == 1 && speed != 0){
                _root.mCar1._rotation -= rotateLeft;
                pressLeft = 0;
        }else if(pressRight == 1 && speed != 0){
                _root.mCar1._rotation += rotateRight;
                pressRight = 0;
        }
        _root.mCar1._x += speed*Math.sin(_root.mCar1._rotation*Math.PI/180);
        _root.mCar1._y -= speed*Math.cos(_root.mCar1._rotation*Math.PI/180);
        }
```

c) Collision detection – testing conducted to check the accuracy and correctness of the hitTest being used.

```
//if the car hit the boundary of the building
if (_root.mCar1.hitTest(_root.roadBoundary1_1){
        crash = true;
        crashSound.start();
        gotoAndStop("Crash", 1);
}
```

d) Car parking detection – testing perform to validate whether the coordinate system that used to check whether the car has been parked is suitable and accurate.

```
parked1 = _root.mCar1._x >=(parking_refer1._x - 3) && (parking_refer1._x + 3) >=
_root.mCar1._x && _root.mCar1._y >= (parking_refer1._y - 3) && (parking_refer1._y
+ 3) >= _root.mCar1._y;
if(parked1){
        if(!sStop){
                timerStop();
                if(parked1){
                        parked1 = false;
                }
        }
}
```

7.3 Integration Testing

Integration testing is also known as module testing. In integration testing, previously tested module/unit was interconnected to ensure that they behave as well as they did as independently tested module/unit. The purpose is to make sure that each component behaved according to its specification during design phase.

After the coding of Active Server Page (ASP) and Action Script 1.0 (Flash MX) has been fully testing, the integration testing between these two modules was done. Below is the example:

By using "Response.write" command, the data passing between ASP module and Flash movie was tested. By checking whether the data outputted was correct or not, we can determine whether the data passing was corrected or failed.

```
<Action Script 1.0>-Scene ScoreBoard
var eData;
eData = new LoadVars();
eData.insertFlag = 1;
eData.timeNeeded = returnTime;
eData.parkingType = parkingType;
eData.send("frmMenu.asp", "", "POST");
<VBScript>-frmMenu.asp
If Request.Form("insertFlag") = 1 Then
        Dim simulationTime : simulationTime = Request.form("timeNeeded")
        Dim parkingType : parkingType = Request.form("parkingType")
        Response.write "time needed = " & simulationTime
        Response.write "parking type = " & parkingType
End If
```

7.4 System Testing

System testing is the last stage of the testing and to ensure that when the whole system embedded in it real environment works according to the user's requirements specification.

7.4.1 Browser Testing

"The Car Parking Simulator" was tested on only one type of the browser, Internet Explorer 6.0.

Table 7.1 Compatibility of the system in various environments

Browser / Operating System	Microsoft Internet Explorer
Microsoft Windows 2000	YES
Microsoft Windows XP	YES
Microsoft Windows ME	YES

As a conclusion, Internet Explorer 6.0 can support the system in various platforms.

7.4.2 Performance Testing

Performance testing addresses the non-functional requirements of "The Car Parking Simulator". In this system, performance testing is carried out by examined the system loading speed, the smoothness of the simulation, the effectiveness of the data manipulation being carried out (data query) and inter-module communication speed.

7.4.3 Acceptance Testing

After the completion of the performance testing, the system has been fulfilled the requirements specification has been defined before. In the next step, acceptance testing that involved end user has been carried out. Acceptance testing is black box testing that give the opportunity to the developer and end-user to verify the system functionality and

usability of the system. [32] The reasons acceptance testing is done to enable user to determine whether the system capable of meeting their expectation functional and non-functional requirements.

7.5 Test Cases

A test case is a documented set of data inputs and operating conditions required to run a test item together with the expected results of the run. The actual results will be comparing with the expected result. If the obtained result agreed with expected result, no error is present .On the other hand, if there are disagreement between obtained and expected result, error is present.

Below are some of the example test cases that has been designed and used for testing purposes:

a) User login test case.

   A set of valid and invalid set of user ID and password has been used to test the login process of the system whether it can accurately verify the identity of the user (registered or unregistered) who is trying to log in.

b) User registration test case.

   A set of invalid user detail (invalid format of IC Number, email address, and user ID) has been prepared for the purposes of checking to see the system can perform the format checking function that has been written correctly.

c) Car parking simulation (parking detection) test case

   The simulator is manipulated to check whether the flash movie is performed as expected. The car is park from different direction (forward

and reverse) to check whether it can be correctly and accurately detected when it is parked.

7.6 Summary

Testing is one of the important and essential phases in the software development life cycle. (SDLC) Testing is carried out through the development process instead of at the end of the system development. It is to ensure that any bugs or errors embedded in the software can be uncovered as soon as possible to reduce the time, money and efforts that needed to identify and correct the bugs and errors. For "The Car Parking Simulator", testing has been performed included unit testing, integration testing and system testing.

Chapter 8: System Evaluation

8.1 Introduction

System evaluation is the ultimate and important phase in the system development before the delivery of the system to the end user. After the implementation of the system, the system was brought to evaluation. Evaluation was related to user environment, attitudes, information priorities, and other concerns before effectiveness can be concluded.

8.2 System Strengths

The strengths of "The Car Parking Simulator" are listed as below:

a) Simplicity of graphical user interface (GUI)

The approaches that have been used in the design of the graphical user interface are simplicity, ease of use and user friendliness. These criteria are important as this will increase the usability of the system. Besides that, the simulation process designed also easy to understand and manipulated.

b) Scalability

Hardware or applications could be easily added to "The Car Parking Simulator" without affecting the existing application as the system is not hardware dependent.

c) Effective errors recovery

The system is reliable as it can detect errors encountered. The validation and verification of the user input is done by using JavaScript. If there is error in the

8.4 Future Enhancement

Some of the functionality of the existing system can be enhanced to improve the quality of the system produced. Below is the functionality of the system that can be enhanced for better quality:

a) Report generation by using Microsoft Excel

Report generation by using Microsoft Excel will be neater, more standard and more information can be included in the report like average simulation result, the most skillful parking type and the parking type with weakest result.

b) 3D car parking simulator

For future enhancement, the existing 2D simulator should be enhancing to 3D simulator. 3D simulator is enabled to provide more realistic environment to the end user as user will feel himself like situated in the real parking environment.

c) Intensive use of hardware in simulation

For the purpose of future enhancement, the simulation by using keyboard key can be replaced by using hardware like adjustable seat, tilt steering and break controller.

d) Additional car parking simulator module which implement automatic gear can be added into the web site.

Currently, only 1 module which is using manual gear manipulation is available to the user. It is recommended to add another module which implements automatic gear to accommodate the need of each type of user.

8.5 Problems Encountered

During the development of "The Car Parking Simulator", several of problems have been encountered. Following are some of the problems encountered during the development of the system.

a) Difficulties encountered during the learning process of Macromedia Flash MX.

Before this, I have limited knowledge on Flash. Therefore, I need to learn by myself in shortest possible time about the flash in order to meet the death line of the thesis.

Solution:

I tried to refer to as many book as possible. Beside that, I also refer to the online sources that available in many website. Sometimes, I also get help from friends and course mates.

b) System set up and configuration

The system set up is important and critical for the proper operation of the software application. Because of the reason of lack of experience and knowledge in setting up the server and database, a long time has been using for that purpose.

Solution:

After referring to online resources, I finally manage to set up the system myself.

8.6 Knowledge Gained

During the development of "The Car Parking Simulator", I gained a lot of knowledge. The following are some of the knowledge I gained from the thesis project.

a) Knowledge on using Macromedia Flash MX

   After nearly 4 months of learning, at last I know how to use flash and the Action Script 1.0 programming language.

b) Knowledge on server and database setup

   The knowledge was learnt during the system setup and configuration process. This knowledge gained will be useful in future.

8.7 Conclusion

The Car Parking Simulator is a web-based system, designed as a simulator which allows all the road user practice car parking and improve their parking skill through trial and error. Through this simulator, road users are able to familiarize themselves with the realistic parking environment in Malaysia and improve their driving skills virtually by knowing how to manipulate a car and the skills needed to park the car into the parking slot.

However, there are some limitations on the system done that need to improve in future enhancement. It needs to be enhanced in order to transform it into more advance system. Despite of the limitation, the system has reasonably achieved all of its objectives.

References

[1] Statistic on number of licensed driver in Malaysia. [ONLINE] Available from http://www.jpj.gov.my/ [Accessed 10 July 2004]

[2] The Free Dictionary.Com. [ONLINE] Available from http://www.thefreedictionary.com/simulator [Accessed 10 July 2004]

[3] Merriam-Webster Online. [ONLINE] Available from www.m-w.com [Accessed 10 July 2004]

[4] Whatis.com. [ONLINE] Available from http://whatis.techtarget.com/definition/0,,sid9_gci211499,00.html [Accessed 10 July 2004]

[5] Whatis.com. [ONLINE] Available from http://whatis.techtarget.com/wsearchResults/1,290214,sid9,00.html?query=2d [Accessed 10 July 2004]

[6] Car Parking Simulator. [ONLINE] Available from http://bbs.carcn.net/bbs/non-cgi/usr/1/1_6020.swf [Access 10 July 2004]

[7] Syahizad Zuriate Bt. Mohamad Zuki. (2004). *Interactive 3D Driving Test Simulation.* Degree Thesis. University of Malaya.

[8] Raydon Virtual Driver. [ONLINE] Available from http://www.virtualdriver.net/ [Accessed 12 July 2004]

[9] Driving Master. [ONLINE] Available from http://www.geocities.com/SiliconValley/Lab/7651/ [Accessed 13 July 2004]

[10] ComputerHope.com [ONLINE] Available from http://www.computerhope.com/os.htm#03 [Accessed 15 July 2004]

[11] ComputerHope.com [ONLINE] Available from http://www.computerhope.com/unix/unix.htm [Accessed 15 July 2004]

[12] ComputerHope.com [ONLINE] Available from http://www.computerhope.com/unix/linux.htm [Accessed 15 July 2004]

[13] ComputerHope.com [ONLINE] Available from http://www.computerhope.com/winxp.htm [Accessed 15 July 2004]

[14] ComputerHope.com [ONLINE] Available from http://www.computerhope.com/winme.htm [Accessed 15 July 2004]

[15] ComputerHope.com [ONLINE] Available from http://www.computerhope.com/issues/ch000575.htm [Accessed 15 July 2004]

[16] Macromedia Flash [ONLINE] Available from http://www.fact-index.com/m/ma/macromedia_flash.html [Accessed 17 July 2004]

[17] Discreet [ONLINE] Available from http://www4.discreet.com/3dsmax/3dsmax.php?id=767 [Accessed 18 July 2004]

[18] An Overview of Adobe Photoshop 7.0. [ONLINE] Available from http://www.qtech.com.au/current/software/Adobe/Adobe%20Photoshop.pdf [Accessed 20 July 2004]

[19] About.Perl. [ONLINE] Available from http://www.irt.org/software/sw011/ [Accessed 20 July 2004]

[20] Webopedia.com. [ONLINE] Available from http://www.webopedia.com/TERM/p/programming_language.html [Accessed 23 July 2004]

[21] Devguru.com. [ONLINE] Available from http://www.devguru.com/Technologies/vbscript/quickref/vbscript_intro.html [Accessed 23 July 2004]

[22] Devguru.com. [ONLINE] Available from http://www.devguru.com/technologies/ecmascript/quickref/javascript_intro.html [Accessed 23 July 2004]

[23] Devguru.com. [ONLINE] Available from http://www.devguru.com/Technologies/vbscript/quickref/vbscript_intro.html [Accessed 23 July 2004]

[24] Wikipedia.com. [ONLINE] Available from http://en.wikipedia.org/wiki/ActionScript [Accessed 26 July 2004]

[25] Connolly, T., Begg C. (2001). *Database Systems: A Practical Approach to Design, Implementation and Management.* 3rd Ed. University of Paisley.

[26] Webopedia.com. [ONLINE] Available from http://www.webopedia.com/TERM/W/Web_browser.html [Accessed 29 July 2004]

[27] Webopedia.com. [ONLINE] Available from http://www.webopedia.com/TERM/W/Web_server.html [Accessed 29 July 2004]

[28] Schach, S. R. (2002). *Object-Oriented and Classical Software Engineering.* 6th Ed. McGraw Hill Publisher.

[29] Kotonya, G., Sommerville, I. (2002). *Requirements Engineering: Processes and Technique.* John Wiley & Sons.

[30] umassd.edu. [ONLINE] Available from http://www2.umassd.edu/cisw3/coursepages/pages/CIS311/LectureMat/test/test1.html [Accessed 20 February 2005]

[31] Galin, D. (2004). *Software Quality Assurance: From Theory to Implementation.* Addison Wesley.

[32] Glossary and Technical FAQs. [ONLINE] Available from http://www.geocities.com/r-davis/3058.html [Accessed 20 February 2005]